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VOL. XLII. MAY–DECEMBER, 1903. No. 174.

Stated Meeting, April 17, 1903.

President SMITH in the Chair.

Dr. Alfred Stengel and Prof. Edward Rhoads, newly elected members, were presented to the Chair, and took their seats in the Society.

Letters accepting membership were read from:

Edward E. Barnard, ScD., Williams Bay, Wis.

Carl Barus, Ph.D., Providence, R. I.

Franz Boas, Ph.D., New York.

Eric Doolittle, Philadelphia.

Basil Lanneau Gildersleeve, LL.D., Baltimore.

Francis Barton Gummere, Ph.D., Haverford, Pa.

George William Hill, LL.D., Nyack, N. Y.

Harmon N. Morse, Ph.D., Baltimore.

Edward Rhoads, Haverford, Pa.

Alfred Stengel, M.D., Philadelphia.

William Trelease, Sc.D., St. Louis.

The decease was announced of Mr. William V. McKean, at Philadelphia, on March 29, aged 82.

Dr. H. F. Keller presented a paper on "Recently Discovered Elements."

Stated Meeting, May 1, 1903.

President SMITH in the Chair.

Letters accepting membership were read from:
Arnold Hague, Washington.
Edward W. Morley, Ph.D., Cleveland.
Sir Henry E. Roscoe, F.R.S., London.
Prof. Hugo de Vries, Amsterdam.

An obituary notice of Joseph M. Wilson was read by Mr. Henry Pettit.

The decease of the following members was announced:
Theodore D. Rand, at Radnor, Pa., on April 24, æt. 66.
Prof. J. Willard Gibbs, at New Haven, on April 28, æt. 64.

Prof. Lightner Witmer read a paper on "The Modern Laboratory of Psychology," which was discussed by Prest. MacAlister, Prof. Haupt, Prof. Keasbey, Mr. Rosengarten and the President.

Stated Meeting, May 15, 1903.

President SMITH in the Chair.

Dr. Francis Barton Gummere and Mr. Eric Doolittle, newly elected members, were presented to the Chair and took their seats in the Society.

The following papers were presented:

On the "Languages of the New England Aborigines, New South Wales," by Mr. R. H. Mathews (see page 249).

"On Radio-Activity," by Prof. George F. Barker.

"On the Properties of the Field surrounding a Crookes Tube," by Prof. Arthur W. Goodspeed (see page 96).

Stated Meeting, October 2, 1903.

President SMITH in the Chair.

Letters accepting membership were read from:

William W. Campbell, Sc.D., Mt. Hamilton, Cal.
William Henry Howell, Ph.D., Baltimore.
Dr. Anton Dohrn, Naples.
Edwin Ray Lankester, LL.D., F.R.S., London.
Joseph John Thomson, D.Sc., F.R.S., Cambridge.

The decease of the following members was announced:

Dr. Thomas George Morton, at Cape May, on May 20, æt. 67
Prof. J. Peter Lesley, at Milton, Mass., on June 1, æt. 84.
Prof. Edward Rhoads, on July 4, æt. 29.
Prof. A. Radcliffe Grote, at Hildesheim, Germany, on September 12, æt. 62.
Prof. Edward North, at Clinton, N. Y., in September, æt. 83.

Prof. Angelo Heilprin made some remarks on "The Causation of Volcanic Phenomena, with New Researches in Martinique," which were discussed by Mr. Joseph Wharton, Prof. Amos P. Brown, Prof. Goodspeed and Mr. Bryant.

The following papers were read:

"The Existing Genera of the Trionychidæ," by Mr. O. P. Hay.

"Artificial Production of Crystallized Domeykite, Algodomite, Argentodomeykite and Stibiodomeykite," by Prof. George A. Koenig and Fred. Eugene Wright (see page 219).

"Some Names of Animals and Plants erroneously paired in Synonymy," by Marchese Antonio di Gregorio (see page 263).

ON THE EXISTING GENERA OF THE TRIONYCHIDÆ.

BY O. P. HAY.

(*Read October 2, 1903.*)

This subject was discussed in an interesting and instructive manner by Dr. George Baur in the PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY, Vol. xxxi, p. 221, 1893. However, the present writer, on investigating the subject, has not been able to agree with Dr. Baur in all his conclusions, disagreeing with him partly regarding the types of some of the genera which he adopts, but especially on the value of some of these genera.

Dr. Baur was undoubtedly correct when he pointed out that the current employment of the name *Trionyx* for the majority of the living Trionychidæ is not justified, and that the genus has for its type *Testudo granosa* Schoepff, called *Trionyx punctata* by Baur, but recorded by Boulenger in his *Catalogue of the Chelonians*, p. 269, as *Emyda granosa*. This is in agreement with the views of Agassiz (*Cont. Nat. Hist, U. S.*, Vol. i, p. 395), who severely condemns the use of the name *Emyda* in this connection. Geoffroy's genus *Trionyx* was divided by Wagler in 1830. *Trionyx* was retained for *Testudo granosa*, while for most of the other species then known the new name *Aspidonectes* was adopted. The names of the species included under it are found in the second column of the table on opposite page. No type was indicated for the genus.

In 1831, Dr. J. E. Gray, in Appendix to Vol. ix of Griffith's *Cuvier's Animal Kingdom*, pp. 18, 19, and again in his *Synopsis Reptilium*, p. 49, applied the name *Emyda* (preoccupied) in place of Wagler's *Trionyx*, and *Trionyx* in place of Wagler's *Aspidonectes*. It is not necessary to add anything here to what Agassiz and Baur have said regarding this procedure, nor to do more than refer to Duméril and Bibron's proposal of the terms *Gymnopus* and *Cryptopus* to replace *Aspidonectes* and *Trionyx* respectively.

In 1836, Fitzinger (*Entwurf Syst. Anordnung Schildkr.*, pp. 119, 120, 127) further subdivided the species of soft-shelled tortoises. He made use of five sections, and these have since been employed as genera. These are *Trionyx*, *Aspidonectes*, *Platypeltis*, *Pelodiscus* and *Amyda*. The species enumerated under each of these are shown in the table already referred to. No types were indicated, but *granosa* was the only one named under *Trionyx*.

Table showing the date of the founding of the genera discussed in this paper, and the type of each.

A species marked with * became a type at that date.

Trionyx.	*Aspidonectes.*	*Platypeltis.*	*Pelodiscus.*	*Amyda.*	*Potamochelys.*
Geoffroy, 1809. subplanus. triunguis (ægyptiacus). cartilagineus (stellatus, javanicus) ferox (carinatus, georgicus). granosus (coromandelicus). euphraticus.	Wagler, 1830. triunguis (ægyptiacus). cartilagineus (javanicus). ferox (ferox, carinatus). spiniferus. muticus.	Fitzinger, 1836. *ferox (ferox, brongnartii).	Fitzinger, 1836. sinensis. triunguis (labiatus).	Fitzinger, 1836. subplana. mutica. euphratica.	Fitzinger, 1843. *cartilagineus (javanicus).
		Bonaparte, 1836. ferox.	Bonaparte, 1836. *sinensis.	Bonaparte, 1836. *subplana.	
Wagler, 1830. *granosus (coromandelicus).	Fitzinger, 1836. triunguis (ægyptiacus). cartilagineus (javanicus). hurum. indicus.	Fitzinger, 1843. ferox.	Fitzinger, 1843. sinensis.	Fitzinger, 1843. subplana.	
		Tyrse.	*Dogania.*	*Chitra.*	*Isola.*
Fitzinger, 1836. granosus.		Gray, 1844. hurum (gangetica). gangetica (javanica). sinensis (perocellata). triunguis (nilotica). spinifera (argus). euphratica (raf-eht).	Gray, 1844. *subplana.	Gray, 1844. *indica.	Gray, 1873. *formosa (peguensis).
Bonaparte, 1836. granosus.	Bonaparte, 1836. *triunguis (ægyptiacus).				
Fitzinger, 1843. granosus.	Fitzinger, 1843. triunguis (ægyptiacus).				

Dr. Baur, in the paper referred to, concludes that inasmuch as the species *cartilagineus* (*javanicus*[1]) was fully figured by Fitzinger, it is the one to be regarded as the type of *Aspidonectes*. In coming to this conclusion he does not give due weight to what Fitzinger himself, in 1843, has done in the case; much less has he noted what Bonaparte had done still earlier. In Wiegmann's *Archiv für Naturgeschichte*, iv, 1, 1838, pp. 136–142, we find a paper by C. L. Bonaparte, entitled "Cheloniorum Tabula Analytica." In 1836 the same author issued at Rome a pamphlet of ten pages which bore the same title. This is understood to be a reprint from the *Giornale Arcadico*. I have not been able to see either the paper in the *Giornale* or the reprint, but Dr. Theodore Gill kindly informs me that the reprint made at Rome differs in only unimportant respects from the paper in the *Archiv für Naturgeschichte*. We find therefore, in this paper of 1836, that Bonaparte accepts two genera of Trionychidæ, *Amyda* and *Trionyx*, with four divisions under the former. With each of his names he mentions a single species, and these species, it seems to the present writer, must be regarded as the types of these subdivisions, all later treated as genera. Under *Trionyx* he mentions *Testudo granosa;* under *Aspidonectes*, *Trionyx triunguis* (*ægyptiacus*); under *Platypeltis*, *Testudo ferox;* under *Pelodiscus*, *Aspidonectes sinensis*, and under *Amyda*, *Trionyx subplanus*.

In 1843, Fitzinger (*Systema Reptilium*, p. 30) presented essentially the same arrangement of the Trionychidæ that Bonaparte had published in 1836. His two genera are *Trionyx* and *Aspidonectes*, the latter having under it five subdivisions. or subgenera. For *Trionyx*, *Aspidonectes*, *Platypeltis*, *Pelodiscus* and *Amyda*, he employed the same species as examples, or types, as did Bonaparte. For the newly proposed subdivision *Potamochelys* he used as type *P. cartilagineus* (*javanicus*). Dr. Baur made the objection that Fitzinger did not define the genus *Potamochelys;* but since the latter author refers to it a well-known species, it must be accepted as a valid genus, in case it really possesses generic characters. That is, technically it meets all the requirements of a generic name.

It may be noted here that Fitzinger's error of 1836, in distributing the species *triunguis*, under the names *ægyptiacus* and *labiatus*, to

[1] In the present paper the specific name now recognized is employed; if the author who is quoted employed a different name, this follows in parentheses.

both *Aspidonectes* and *Pelodiscus*, was not repeated in his work of 1843.

We may then, it appears to the writer, regard it as established that the type of the genus *Trionyx* is the species *granosus;* of *Aspidonectes*, the species *triunguis;* of *Platypeltis*, the species *ferox;* of *Pelodiscus*, the species *sinensis*, and of *Amyda*, the species *subplana*.

We must now consider how these determinations are to affect the work of subsequent writers, especially that of Gray, Agassiz, and Baur.

In 1844, Gray (*Cat. Tort., Croc.* and *Amphib.*, p. 46) established the new genera *Tyrse*, *Dogania* and *Chitra*, besides propagating his erroneous uses of the terms *Trionyx* and *Emyda*. The type of *Chitra* is *Trionyx indica* Gray, and this genus is yet recognized as a valid one. The type of *Dogania* is naturally the only species mentioned under it, *subplanus;* but this had already in 1836 been made by Bonaparte the type of *Amyda*, from which fact it follows that *Dogania* is a synonym of *Amyda*. Under *Tyrse* there were named six species, but no type was selected. In his later publications Gray dropped from *Tyrse* all the species originally included under it, except *triunguis* (*nilotica*). We must then suppose that he regarded this species as the type of the genus; but this was, as we have seen, the type of *Aspidonectes*, made so by Bonaparte in 1836. *Tyrse*, therefore, becomes a synonym of *Aspidonectes*.

Agassiz accepts *Trionyx ferox* as the type of *Platypeltis*. While rejecting *Pelodiscus* as a valid genus, he correctly states that it rests on *Trionyx sinensis* Wiegm. He does not say what he regards as the type of *Aspidonectes*, but he includes under it *Trionyx spiniferus*. *Amyda*, he states, has for its type LeSueur's *Trionyx muticus;* and he tells us that this generic name was vaguely applied by Fitzinger to one of his genera. As we have seen, no type was indicated for *Amyda* in 1836, but in 1843 Fitzinger names under the genus only the species *subplana*. There certainly was no vagueness in this procedure. Furthermore, Bonaparte had already in 1836 indicated the same species as the type of *Amyda*.

As already stated, Dr. Baur regarded the species *cartilagineus* as the type of *Aspidonectes* and *Trionyx muticus* as the type of *Amyda;* whereas Bonaparte in 1836 and Fitzinger in 1843 made *triunguis* (*ægyptiacus*) the type of the former, and *subplanus* as the type of the latter. Baur recognized *Testudo ferox* Schweigg. as the type of

Platypeltis, *Trionyx sinensis* as the type of *Pelodiscus*, and *T. subplanus* as the type of Gray's *Dogania*. Dr. Baur also recognized as valid genera *Cycloderma* Peters, with its type *C. frenatum*; *Cyclanorbis* Gray, with the type *Cryptopus senegalensis*; *Isola* Gray, with the type *Trionyx leithii*; *Chitra* Gray, with the type *Trionyx indicus*, and *Pelochelys*, with the type *P. cantorii*.

Leaving out of consideration the genera *Pelochelys*, *Chitra*, *Cycloderma* and *Cyclanorbis*, as being valid, and likewise invulnerable on other grounds, as well as the various genera founded since 1846, and cited by Boulenger as synonyms of his *Trionyx*, let us consider the content and value of the others.

In his classification of the Trionychidæ, Dr. Baur gave great weight to the amount of reduction of the posterior nares by the inner and posterior extension of the maxilla. To the present writer this character seems to be of little value. The two conditions of being "reduced" and of being "not reduced" can hardly be defined, and they are probably connected by every gradation. It is solely on this character, so far as we know, that he has separated generically his *Pelodiscus agassizii* and *Platypeltis crox* (*Amer. Naturalist*, xxii, p. 1121; PROC. AMER. PHILOS. SOC., xxxi, p. 217).

Trionyx, with *Testudo granosa* as type, must be regarded as a valid genus.

Aspidonectes Wagler, restricted by Bonaparte, 1836, and Fitzinger, 1843, with *Testudo triunguis* Forsk. as type, must be applied to the group designated by Boulenger I, B, 3 (*Cat. Chelonians*, p. 245), and to that included by Baur (PROC. AMER. PHILOS. SOC., xxxi, p. 220) under the name *Pelodiscus*, with the exception of his *P. agassizii*. In the same genus the present writer would include Boulenger's group I, B, 2, containing the species *cartilagineus*, *formosus* and *phayrei*. These were placed by Baur in the genus *Aspidonectes*, as this was limited by him; but did the group form a genus distinct from that whose type is *Testudo triunguis*, it ought to be called *Potamochelys*; since, as already stated, Fitzinger in 1843 made the species *cartilagineus* (*javanicus*) the type of this genus. This group differs from the preceding only in having "the alveolar surface of the lower jaw with a strong longitudinal symphysial ridge," a character which appears to the writer as insufficient. In the same genus must be placed *Trionyx subplanus* Geoffr. As

already said, Baur recognized it as the type of *Dogania;* but if it is a member of a genus distinct from *Aspidonectes*, it must be called *Amyda*, according to the systems of both Bonaparte and Fitzinger.

Platypeltis comes next, having as its type *Testudo ferox* Schneider. It will include all the American soft-shelled tortoises, except *Aspidonectes californiensis* (Rivers). The writer believes that this group is sufficiently characterized by the possession of only seven pairs of costal plates. The smooth or granular condition of the skin of the young is possibly a character of generic value. In this group must be included LeSueur's *Trionyx muticus*. There appear to be no characters which justify its separation as a distinct genus. Baur makes it the type of *Amyda*, following Agassiz. The only character given by Baur to distinguish it from *Platypeltis spiniferus*, for instance, is the separation of all the costals at the midline by means of neurals; whereas in the other American Trionychidæ the hindermost pair are in contact. This difference depends wholly on the greater or less development of the seventh neural plate; and this will almost certainly be found to vary in different species and in different individuals of the same species. Some importance has been attributed to the absence in *muticus* of the commonly occurring ridges, or papillæ, on the septum of the nares; but this character appears to the present writer to be of slight value. On similar characters the Trionychidæ might probably be divided into as many genera as there are species. If, however, *Trionyx muticus* is to form a distinct genus, a new generic name must be coined for it.

For Boulenger's group I, B, 1, Dr. Baur accepted Gray's generic name *Isola*, having, according to Baur's statement, *Trionyx leithii* as its type. This is, however, an obvious error. The genus was proposed by Gray in 1873 (*Proc. Zool. Soc. Lond.*, p. 51) for the reception of *Trionyx peguensis* Gray, and this is, according to Boulenger, a synonym of *Trionyx formosus*. *T. leithii* was afterward (*Ann. Mag. Nat. Hist.* [4], x, p. 157, 1873) referred to the same genus with some doubt. *Isola* is therefore a synonym of *Aspidonectes*, as recognized in the present paper.

The group of tortoises referred by Baur to *Isola* includes the species *gangeticus*, *hurum* and *leithii*. These species differ from those of *Aspidonectes*, especially in possessing two neural plates between the first costals. It appears to be worthy of generic rank. A search among the generic names which have been applied to the

members of the genus shows that none of them is available. I therefore propose the name ASPIDERETES (*ασπίς*, a shield, and *ερέτης*, a rower). The type is *Trionyx gangeticus* Cuvier, and the other living species will be *A. hurum* and *A. leithii*. It seems probable that a number of fossil forms must find their place in the genus.

Stated Meeting, October 16, 1903.

President SMITH in the Chair.

The following papers were presented:

"Evolution and Epigenesis—New Light on an Old Problem," by Prof. E. G. Conklin, which was discussed by Gen. Wistar.

"A Review of Parthenogenesis," by Mr. Everett F. Phillips, communicated by Prof. E. G. Conklin, which was discussed by Gen. Wistar.

A REVIEW OF PARTHENOGENESIS.[1]

BY EVERETT F. PHILLIPS,
HARRISON FELLOW IN ZOOLOGY.

(*Read October 16, 1903.*)

General Introduction.

In the great majority of cases the sex cells disintegrate unless they unite with the products of the opposite sex of the same species, but in many cases in the animal kingdom cells are given off from the germinal epithelium which, without fertilization, are able to undergo development, as is manifested by cell division. That these are true ova is evident from their origin, appearance, behavior and fate, and the only difference between these and eggs requiring fertilization is that they have in them the ability to divide mitotically without receiving the external stimulus given by the male sex cell. To this phenomenon the name Parthenogenesis is applied.

The importance of facts of this kind cannot be overestimated, especially from the standpoint of cytological investigation. The various ways in which these eggs behave during maturation and the sex relations connected with the different kinds of Parthenogenesis give us most valuable guides in our study and afford invaluable material toward the solution of that much debated problem—the determination of sex.

In view of the importance of the subject and the scattered condition of the literature, it has seemed desirable to give a brief summary of the most important work done, together with a literature list of all important papers. Most attention has been given to the case of the Honey Bee, since it was on this form that Dzierzon worked and especially since the most conflicting theories have been advanced concerning it. A somewhat lengthy discussion of this one case will make clearer what follows concerning other species, but it is hoped that this will not make it appear that I consider this the most important case, but that it is simply used as a basis for the later discussion.

The preparation of this paper was begun at the suggestion of Prof. E. G. Conklin to fill partially the need of some such review. I wish at this time to express my appreciation of the help

[1] Contribution from the Zoological Laboratory of the University of Pennsylvania.

and suggestions given me by Dr. Conklin all through the work. I wish also to state that I have referred constantly to the review of Taschenberg (1892) and especially to his long literature list. His paper is an excellent review up to the time of its publication.

Historical Sketch of the Theory.

The word Parthenogenesis (Greek *παρθένος*, a virgin, *γένεσις*, production) was first used by Owen[1] in the sense of Alternation of Generations.

In 1856, in his classic paper, "Wahre Parthenogenesis bei Schmetterlingen und Bienen," Carl Th. Ernst v. Siebold used the word in the sense of the development of eggs without fertilization, in which sense it has since been universally adopted. Previous to 1856 the phrase *lucina sine concubitu nulla* and similar terms were used in practically the same sense in which the word parthenogenesis is now used.

For the first observations on parthenogenetic development we must go back to Aristotle, as is true for the beginnings of so many lines of observation. This old Greek scientist recorded extensive observations on the Honey Bee which will be referred to in another place.

The next writer who gave any intimation of a belief in such phenomena was Goedart (1667) who succeeded in raising larvæ from eggs laid by an unfertilized female of *Orgyia gonostigma*. After that Leenwenhoek (1695), Blancard (1696), Albrecht (1706) and Réamur (1737 and 1741) recorded somewhat similar results.

In 1745 Bonnet, of *emboîtement* fame, described, rather fully, parthenogenetic development in plant lice. Oscar Hertwig, in his "Historical Account of Embryology," in the *Entwicklungslehre*, speaks of Bonnet's work in the strongest terms and does not hesitate to designate it as marking one of the milestones in the history of embryology.

Just one hundred years after this, Dzierzon (1845) announced his theory on the parthenogenetic development of the drone eggs of the common bee, *Apis mellifica*, which will be treated more fully in a later section. During this period of one hundred years a

[1] V. v. Prosch, in 1851, in *Om Parthenogenesis og Generationsvexel, et Bidrag til Generationstaeren* (Kjobenhavn, Trijkt hos J. C. Scharling), used the word in the same sense.

number of papers appeared in which the development of unfertilized eggs was described, but the importance of the observations was not recognized fully until after Dzierzon published his first paper. This paper, published in a bee journal, may well be looked on as the starting-point of the Theory of Parthenogenesis, since it started a very important discussion and marks the beginning of a host of work along similar lines.

The most important papers of the period between 1745 and 1845 will be found in the literature list at the end of this paper. It does not seem desirable to go into a detailed account of these earlier papers since, while they are valuable, the greatest additions to our knowledge of these phenomena have been made since the time named.

As stated on a preceding page, more attention has been paid to the parthenogenesis of the Honey Bee, in the preparation of this paper, than to any other form. A full statement of the present state of our knowledge of the phenomena in this species will make clearer what follows concerning other species.

Theories on the Honey Bee Previous to 1845.

Before discussing the various theories and experiments on the parthenogenetic development of the drone eggs of the common bee, it may be of interest, from the historical standpoint, to review briefly the various theories put forth previous to 1845 which were used to explain the peculiar phenomena observed in the hive in regard to the sex of the bees. Since the bee is of economic value it has been the object of much investigation for centuries, and for this reason the peculiarities of its development have long been known.

Aristotle, in his *Historia animalium*, wrote: "All persons are not agreed as to the generation of bees, for some say that they neither produce young nor have sexual intercourse; but that they bring their young from other sources. . . . Other persons affirm that they collect the young of the drones from any of the substances we have named (flowers of the honeysuckle, reed or olive), but that the rulers (queens) produce the young of the bees (workers). . . . Unless the ruler (queen) is present drones only are produced. Others affirm that they have sexual intercourse, and that the drones are males and the bees females." In his *De generatione animalium* he wrote: "The drones develop in a queenless

stock" and "The bees produce drones without copulation." Here we get a rather clear statement of what was rediscovered centuries later.

Huish gives an account of other theories advanced, and a large part of the information from which these summaries of the earlier work were made is from his paper.

1. Schirach says that the hive consists of three kinds of bees: (1) queens, the mother of the hive, (2) drones or males, and (3) workers, a middle sex with greater affinity to the queen but destitute of procreating powers. The parts which belong to the queen lay concealed in imperceptible minuteness, and just as soon as they receive the necessary space for their expansion, increase takes place in size and a queen is developed. Drones from fertile workers and queens arise from false or corrupted eggs, to which the name "abortion" is applied. Some of the opponents of Schirach held that all workers lay eggs, the view being based on the fact that in queenless hives drones are produced by the "fertile workers."

2. Herold was one of the greatest opponents of Schirach, maintaining that the queen copulates with a male worker, producing male and female workers. The true workers, male workers, perform their duties outside the hive, collect honey and pollen and copulate with the queen and female workers which remain inside the hive. The female workers lay eggs (fertilized by male workers) which produce drones of no sex whatever. This was at once proven false by an anatomical examination showing that the drones are males. The hive was then considered as an Amazon republic with drones raised to the rank of males or husbands, a view that had many supporters up to the time of Heinmetz.

3. Heinmetz proposed a double genealogical tree for the bee family, symmetrically for both the male and female lines. (1) The queen as the great mother bee copulates with a male worker and lays eggs producing insects like their sire (male workers). If laid in large cells they produce great male bees, if the rudiments of a great male exists in the egg.[1] "But as only small male workers are the issue, although they may be bred in large cells, the conclusion must be drawn that in these male eggs the rudiment was only existing for small workers and that from these no great male bees are pro-

[1] Quo'ation from Huish. See former reference.

duced." (2) The queen also lays eggs producing females which resemble the queen or are female workers or mothers of the drones. The working bees are partly male and partly female and are derived from the queen. On the other hand the drones are from a mother drone, as follows: A mother drone copulates with a great male drone and lays only drone eggs which develop as small drones or as great drones (like their sire). Needless to say, a theory of this kind had many opponents.

4. Voigt and Lucas. These men separately maintained that the queen is the mother of all the bees, laying in six months of the year an almost incredible number of fertilized eggs, from which in twenty to twenty-four days are produced common workers which are both male and female. The males *by their mouths* fructify not only the queen but common female workers or mother drones, and from eggs laid by the latter in May and June drones are developed. This fructifying or vivification of all these eggs is performed and executed by the principle of life or by the animating creative spiritual power, *aura seminalis*, contained in the spittle, the process of which is so very visible in the frequent application of the proboscis of the common male bees to that of the queen. This theory was based on the facts that workers and queens can compose a perfect hive without adding drones and that workers produce drones.

5. Haumann maintained that the queen is the only mother of her like and of workers and drones. The bees (workers) are nurses and co-operate in breeding, and without them the eggs prove abortive. In the small cells the sex property of female eggs is lost and the egg becomes a common bee, but in a royal cell a queen or fertile mother, and in drone cells a spurious mother drone. The male eggs in common cells become bees devoid of sex, and in drone cells a male or drone. Hummel attacked this most violently on the principle that it is at variance with every analogy of nature to invest an insect with the power of altering the sex character of an egg after laying, and impart to it a power which did not belong to it in its original nature. From Hummel's argument was founded one of the chief objections to the hypothesis advanced by Huber, that a common bee is possessed of the power of generating a queen from a common egg.

6. Strube held that the queen with a double-branched ovarium lays male and female eggs. The male eggs are placed in small cells and become male workers. The female eggs become queens

in queen cells or degraded queens. The remaining workers are those which can breed only drones; they are fertilized by the male workers and not by drones. The eggs of drones of May are laid by degraded queens. The ovaria of these queens cannot develop in the small cells and are weakened. During honey flow these degraded queens lay eggs. The eggs from which early drones arise are laid in the autumn and are outside the heat of the hive in winter, developing in spring. It is only when there is a deficiency of male workers that the queen is fertilized by a drone.

Habits of the Bee.

In order to appreciate fully the experimental work done on the subject of the parthenogenetic development of the male bee, it is necessary to know something of the habits of the different members of the hive or colony. The habits of no insect are better known to zoologists, but a very brief statement may not be out of place here, although necessarily incomplete.[1]

At the age of about five days the queen takes what is commonly spoken of as her "marriage flight," flying from the hive to meet a drone. She returns in about half an hour with the organs of the male generally hanging to her; the copulation taking place on the wing and the male being killed in the operation. Before the marriage flight the spermatheca is filled with a clear fluid and afterward it contains a white liquid, the seminal fluid, the number of spermatozoa having been estimated at several millions. Since a queen lays during her lifetime, averaging three or four years, a total of possibly 500,000 eggs, it will be seen that the apparatus for preserving sperm cells is very perfect. The spermatheca opens by a tube into the oviduct, the tube being surrounded by highly enervated muscles and accompanied by accessory glands which probably nourish the spermatozoa. These muscles must contract during the laying of a

[1] The facts here given regarding bees are gathered from various sources and from personal observation, and only such facts are here introduced as seem necessary to a better understanding of the discussion following. For more detailed accounts any book on apiculture may be consulted, of which the following are some of the well known examples:

Root, *A B C of Bee Culture*, Medina, O.

Cook, *Manual of the Apiary*, Lansing, Mich.

Benton, *The Honey Bee*, U. S. Dept. of Agriculture, Washington, D. C.

drone egg, so that no sperm cell can reach the oviduct to fertilize the egg.[1]

During the active season the queen can under stress of circumstances lay eggs at the rate of four a minute, although generally much slower, and in twenty-four hours can lay over 4000 eggs, the total weight of which is more than the weight of her own body. The eggs are laid at the bottom of the cells, the abdomen of the queen being put into the cell during the oviposition, and the eggs are attached to the middle point of the base of the cell by the end opposite the micropyle. In the hive the eggs are laid in what are known as brood cells, generally situated near the middle of the hive, these cells being used for the storing of honey when not used for larvæ. The cells from which the workers hatch are about one-fifth of an inch across, while those from which drones hatch measure about one-fourth inch; these being spoken of as worker and drone cells respectively. The royal or queen cells, in which queens develop, are shaped like an acorn and occupy about the space of three ordinary cells, these being built naturally only when the hive is queenless, when the queen is to be superseded by another on account of her age, or at the swarming season when the hive is to be divided. The queen passes quickly from one cell to another, laying in each an egg which almost invariably develops according to the size of the cell. This necessitates a very fine manipulation of the entrance of the spermatheca or seminal receptacle, as the sex is dependent upon whether a spermatozoon is allowed to escape or not.

Various theories have been advanced to explain the power of the queen to control the escape of the spermatozoa since we cannot believe that it is a conscious act, in spite of statements to that effect. A very plausible one is that the difference in the size of cells causes a difference in the pressure of the abdomen, and by a reflex nervous action, of the nature of which we know nothing, the muscles are contracted when the abdomen is put into a drone cell. Kückenmeister was probably the first to advance this theory. In opposition to this Cook (1881) and many others cite the fact that queens lay fertile eggs in cells where the walls have not yet been built up, and in such cases pressure on the abdomen could play no part. We have not as yet been able to account for the nearly

[1] For a description of these parts of the queen see Cheshire, F. R. (1886).

infallible ability of the queen to determine the sex of each egg. Probably queens never lay eggs in queen cells, but when a new queen is desired the workers build out a queen cell over a cell containing a very young worker larva (less than one day old). At any rate, this is the general method of procedure, although I have seen a drone-laying queen lay eggs in a partly built queen cell.

When a hive becomes hopelessly queenless it frequently happens that certain of the workers begin to lay eggs, which of course produce nothing but drones since a worker never copulates with a drone. These are called Fertile or Laying Workers, and are far more easily produced in the races of bees found in Eastern Asia than in the Italian bees.

The species *Apis mellifica* is divided into several races, the principal differences being in the coloration of the segments of the abdomen, although the instincts differ slightly, especially as regards the production of queens. The two races on which experiments on parthenogenesis have been performed are the Germans and Italians. The former are almost entirely black, while the latter have bands of yellow on the abdomen, three to five in number, or occasionally six. This difference has been used as a means of determining the truth of the parthenogenetic development of the males.

The Theory of Dzierzon.

The parthenogenetic development of the male eggs of the bee, *Apis mellifica*, was first observed by Johannes Dzierzon, a priest of Karlsmarkt, Germany. He was a bee-keeper of many years' experience and a good observer. The theory was first announced in the *Eichstadt Bienenzeitung* in 1845, and in 1852 was published in book form. His arguments were briefly as follows:

(1) [1]A queen to be of any value must be fertilized by a drone. This takes place on the wing, high in the air. Drone eggs are not fertilized, but worker and queen eggs always are. "[2]In copulation the ovaries are not fecundated, but the seminal receptacle, that little

[1] The results of his investigations and his conclusions appeared in the *Eichstadt Bienenzeitung* and other journals, most of which were not accessible in the preparation of this paper. They were recorded in a very large number of short papers and it does not seem desirable to refer to all of them at this time. A complete list of the writings of Dzierzon can be found in *Bibliotheca Zoologica*, II, O. Taschenberg, to which the reader is referred.

[2] The quotations from Dzierzon are translations made by Lowe (1867).

vesicle or knot which in the young queen is filled with watery moisture, is saturated with semen, after which it is more clearly distinguishable from its white color." The supply of semen is enough for a lifetime. No clipped queen can be fertilized, as copulation never takes place in the hive. "The power of the fertile queen, accordingly, to lay worker or drone eggs at pleasure is rendered very easy of explanation by the fact that the drone eggs require no impregnation, but bring the germ of life with them out of the ovary; whilst otherwise it would be inexplicable and incredible. Thus the queen has it in her power to deposit an egg just as it comes from the ovary, and as the unfecundated mothers lay it; or by the action of the seminal receptacle, past which it must glide, to invest it with a higher degree, a higher potency, of fertility and awaken in it the germ of a more perfect being, namely a queen or a worker bee."

(2) The most important point in the theory is that "All eggs which come to maturity in the two ovaries of the queen bee are only of one and the same kind, which when they are laid without coming in contact with the male semen become developed into male bees, but on the contrary when they are fertilized by male semen produce female bees."

This, as v. Siebold expresses it, "strikes at the root of and completely abolishes the time-honored physiological law that an egg which is to be developed into a male or female individual must always be fertilized by male semen." Dzierzon refers to Riem, a French naturalist, for the fact that fertile workers lay only drone eggs (a fact now well known from many sources), and Mme. Jurin found on anatomical investigation that these fertile workers were queens with the spermatheca aborted and the ovaries not fully developed. Dzierzon also asserted that a queen must be able to lay either drone or worker eggs *at will*.

v. Siebold wrote: "We might beforehand expect that by the copulation of a unicolorous black-brown German and reddish-brown Italian bee the mixture of the two races would only be expressed in the hybrid females or workers but not in the drones, which are produced from unfecundated eggs. They must remain purely German or purely Italian according as the queen selected for the production of hybrids belongs to the German or Italian race." In 1854 Dzierzon wrote: "Continued observations of the hybrid hives also must be no less adapted to raise the veil, more and more to penetrate into the obscurity and finally bring the mysterious

truth to light. If the drone egg does not require fertilization, Italian mothers must always produce Italian drones and German mothers, German drones, even when they have been fertilized by drones of another race." His faith in this proposition was so strong that when in a few years he found one case in which it did not seem to hold good he gave up his theory, just when it was becoming generally accepted, and as an explanation took up the old exploded theory of Swammerdam of the vivifying action of an *aura seminalis*. Either the experiments of Count v. Berlepsch[1] or the work of v. Siebold reconverted him, for in 1861 he reiterated his belief in his theory.

Experiments and Later Investigation on Bees.

Owing to the fact that the phenomena connected with parthenogenetic development of the Drone Bee are so striking, even to a person not used to scientific methods of investigation, many experiments have been tried to test the Theory of Dzierzon. Journals devoted to Bee Culture as well as more strictly scientific publications have recorded a large number of experiments, of which but a few can be mentioned here.

Lowe (1867), after several years of experimenting with hybrid hives, denied the truth of Dzierzon's Theory. With Italian queens fertilized by common black drones he could get no definite results, but with Egyptian queens fertilized by black bees he obtained many drones which appeared to have characteristics of the male parent. His work was not so carefully recorded as was that of Perez which will be mentioned later.

Landois (1867) put worker eggs in drone cells and drones were produced, and *vice versa*. This he did many times and his results were verified by the presence of the little piece of wax, to which the eggs had been attached, sticking to the cocoons. He in every case cut out a little piece of the wax at the base of the cell and stuck this with the egg attached into the new cell, so that the egg was not injured by the transfer. His earlier experiments were not successful, due to imperfect manipulation. His conclusion then was that sex in the bee is determined by the food given the larva

[1] v. Berlepsch upheld the theory in a large number of papers in the *Eichstadt Bienenzeitung*. For a list of his writings see *Bibliotheca Zoologica*, O. Taschenberg, Zweiter Band, pp. 252–3.

and not by fertilization. It is known that after the eggs are hatched, at about the third day, the workers pour into the cell a food paste for the nourishment of the larva. Great quantities of this are eaten for six days and then the workers cap the cell, and in ten or eleven days the bee in its adult form comes out. The cap put over the smaller worker cells is flat; that over drone cells, arched. v. Siebold (1868), in answer to this theory, points out that sex is differentiated early in insect larvæ. Herold, for *Pieris rapæ*, was able to tell sex early. On the other hand Meyer did not see this in caterpillars only a few days old. Weismann, in *Musca vomitoria* and *Sarcophaga carnaria*, confirms Herold, but is not so sure in the case of *Corethra plumicornis*. Leuckart (1865) found first traces of external genitalia on the sixth day in Apis. v. Siebold insists that all embryos (queens included) up to the sixth day get food paste (digested chyle paste). The queens continue to get this, and from that time on the workers and drones get undigested honey and pollen. The food of the drones and workers is therefore the same. Landois thinks the drones of unfertile queens and of fertile workers are due to scanty nourishment or weak larvæ, for in *Vanessa urticæ* only males are produced if badly fed. v. Siebold (1871) does not find this true in *Polistes gallica*, for in the spring, when food is scarce, workers are produced; and Cuenot (1899) denies the truth of all such statements which make the sex depend upon nutrition.

Sanson and Bastian (1868) attempted to repeat the experiments of Landois, but in every case when the egg was put in a different cell the workers in the hive carried it outside. Never in a single case was the egg allowed to develop and they were therefore led to deny the experiments of Landois. The reason for their failure, as pointed out later by Landois, was imperfect manipulation. They cut out the entire bottom of the cell and stuck it in place by melting the edge with a hot needle, and this made such a bad job as compared with the work of the workers that they cleaned it out. Sanson (1868), in opposition to Landois, also cites cases of the production of drones in worker cells. This is now well known, as is also the converse, and this fact alone is enough to overthrow all of the work of Landois.

Perez (1878) put a pure Italian queen fertilized by a French drone into a hive with pure French workers and no drones. Later in the season he collected and examined carefully three hundred

drones from this hive. If these drones were produced from unfertilized eggs then they should, since the queen was pure Italian, show no trace of French characteristics. Perez first examined pure Italian and pure French drones from other colonies and determined what were the varietal markings in each case; and with these characteristics well mapped out examined the three hundred drones, and found one hundred and fifty-one pure Italians, eighty-three pure French and sixty-six showing various gradations between the Italian and French varieties, indicating that one hundred and forty-nine, almost half, had some French characteristics, which he held must have been derived from the French drone that had fertilized the queen.

Arviset (1878) announces a similar case, and Matter (1879) writes of three hundred black drones taken from the hive of an Italian queen fertilized by a black African drone.

Sanson (1878), in a reply to this paper, criticised the experiments of Perez, claiming that in this case the results had been modified by atavism, all bees having been derived from an original black variety. The possibility of the impurity of the queen was also suggested. He insisted that the purely parthenogenetic origin of drones was undoubted. It cannot be claimed that the contraction of the spermathecal opening is due to the pressure of the side of the cell on the abdomen of the queen, since drones often develop from unfertilized eggs in worker cells and workers from fertilized eggs in drone cells. He insisted that in the ovary all eggs are male and impregnation is necessary to produce female characters. If a queen is frozen and revived it is found that she afterward lays only drone eggs, and an examination of her spermatheca shows only dead spermatozoa.

Girard (1878) thinks that probably these hybrid drone eggs were laid by the hybrid workers which would result from the union of the Italian queen and French drone, and Hamit (1878) also takes the same stand; but according to the testimony of bee-keepers fertile workers are rare in a well-regulated hive, except in the cases of the Eastern varieties (Syrian, Palestine, etc.).

Perez replies to these criticisms in a later paper. The queen was obtained from a well-known firm of Italian apiarists and there can be no doubt of her purity, since the mother of the queen used in the experiment later produced many pure Italian queens. The possibility that the hybrids and French drones might be visitors

from other hives is denied by Perez on the ground that such visitations are not usual between hives, but this argument is not substantiated by other investigators. The hive used for the experiment had been used formerly for a pure French queen, but she could not have laid any of these eggs since considerable time had elapsed, and at any rate she would not have produced any of the sixty-six hybrids. The hybrids and French drone eggs could not have been laid by fertile workers since the drones all appeared at the same time.

Cook (1879) claims that these experiments are not wide enough to overthrow a theory which has so many arguments on the other side. Queens reared in autumn, when there are no drones, pass the winter as virgins and always after produce only drone eggs. Deformity and clipping of wings to prevent the marriage flight and consequent fertilization produces the same result. He suggests that possibly the queen used by Perez was a hybrid. (This is emphatically denied by Perez.)

The argument of atavism used by Sanson is such that a positive denial is impossible. One cannot but get the idea that Sanson was trying to make the facts fit his theory, however valid the argument may be.

In the face of the careful work of Perez it was evident that there must be some other explanation for these results, and it occurred to me that perhaps the mistake in the work came in when Perez mapped out the racial markings. In a recent number of a bee journal I noticed a letter from a novice at bee raising, complaining that some queens guaranteed to be pure Italians produced black drones, although the workers were yellow. I consequently decided to leave the matter to a bee-keeper of many years' experience, and wrote to Mr. E. R. Root, one of the editors of *Gleanings in Bee Culture*, and the following, by permission, is quoted from his letter: "We have repeatedly had queens direct from Italy that were supposed to be as pure as any stock could be; yet the drones from these queens varied greatly in their markings. Some of their sons would have a great deal of yellow on them, while others would be quite dark. If Perez had seen these drones he would have concluded some of them were French, some German and some Italian. Now the remarkable fact is that *bees* (workers) from these queens were all uniformly marked. They showed all the chracteristics of pure stock."

"Pure Italian queens vary all the way from a jet black to a bright yellow. We had one daughter from an imported Italian that was very black; but her bees (workers) were uniformly well marked and showed all the characteristics of pure Italians. Some of the queen daughters of the imported queen are quite yellow and some quite dark. Any one who attempts to judge of the purity of drones or queens by their markings has much to learn about bees."

I put a great deal of confidence in the statements of Mr. Root, since he is thoroughly informed in things relating to bees from a practical standpoint and is a man of high standing in his line of work. We must conclude then that in the honey bee we have a case in which certain racial characters are constant only in the abortive females, although they do not normally enter into the reproduction of the species. Since these markings are not a constant character, even in pure drones, any attempt to use them as tests of hybridism is not warranted.

A comparatively large number of cases have been recorded of hermaphroditic or androgynous bees. This fact was long since noticed by Lucas, more recently by Doenhoff, Menzel and Engster, and in 1864–5 by v. Siebold and Leuckart. There is a mixture of male and female characters, varying in different individuals, in both internal and external organs. Very often on each side of the body a few testicular cords and a few ovarian tubes, a well-developed male copulatory apparatus and a sting are developed, or one side of the body may be entirely male, the other side female. According to Leuckart all these must be regarded as workers with some male characteristics. The explanation offered is that fertilization did not take place here until after the male characters had become too well fixed to be thrown aside by female characteristics.

Boveri (1901) in a late paper suggests that such cases are due to the late fertilization of the egg, after mitosis has commenced, and as a result part of the cells have paternal characters and are therefore female, while the unfertilized portion remains male. This would, of course, easily explain the great differences in hemaphroditic bees.

There are numerous cases on record of queens which have taken their marriage flights and on their return to the hive, and during the rest of their lives, have laid eggs which never develop. The opponents of the theory of parthenogenesis eagerly take up a case

of this kind, claiming that for some reason the queen has not been ertilized and that on this account her eggs will not develop. v. Berlepsch was probably one of the first to make any observations on this line, and his conclusion was that it was due to some pathological condition of the queen.

Claus and v. Siebold (1873) took up this subject and carefully studied several cases that came to their notice. One of the cases was that of an Italian queen, born May 15, began to lay June 15 and continued until October 5, when she was killed. Her eggs did not hatch and an examination showed that her oviducts were normal, spermatozoa present in the spermatheca, but the ovarian tubes were degenerate. The conclusion, from this and other cases examined, was that all such cases of sterile queens are probably due to some irregularity in the formation of the ovum, and especially of the vitellus. Leuckart (1875) reports other cases examined and corroborates Claus and v. Siebold.

Of the opponents of the theory of Dzierzon, none perhaps are as radical as Ulivi (1874–82). His views were briefly as follows: Queens are usually fertilized in the hive, and he claims to have witnessed the act of copulation several times. The spermatheca, on the return from the so-called "marriage flight," is clear and contains no spermatozoa, as was demonstrated by numerous examinations. The marriage flight is explained as being merely for exercise. Drones are not mutilated in copulation, and on examination the white appendage which is always seen on the queen on her return from the marriage flight is found to be excreta. Every egg, male or female, is fertilized. Queens that were never allowed to fly (their wings being clipped) were put in hives without drones and laid no egg or eggs that did not hatch. Every queen whose spermatheca is distended has been fertilized. None of the eggs of a queen that has never met a drone will hatch. There is no such thing as a fertile worker. Fertilized eggs will keep through the winter and hatch out in the spring. He also claims that there can be no true parthenogenesis when a fertile copulation is admitted. The effect of the spermatic threads does not consist of a simple excitement of the supposed vital germ preëxisting in the egg, but of a real infusion of the absolute principle of life. No transformation of sex can be effected by spermatic injection. It need scarcely be added that such views have found no supporters.

For the past two or three years Dickel has been advancing a new

theory in regard to the determination of sex in the bee and he has some supporters, although the number of these seems to be decreasing. His views are briefly the following: Eggs laid by unfertilized queens or fertile workers produce drones, but these differ from the drones of a colony with a fertile queen. The egg before fertilization contains only male elements, the sperm cell only female, and after union of the two these are equally balanced. A fertile queen can lay only fertilized eggs since she cannot withhold sperm cells. The workers, in crawling over the brood cells just after the eggs are laid, pour out a secretion which penetrates the chorion of the egg. The wax, in the formation of brood cells, is kneaded in the mouths of workers and is impregnated from the salivary glands with a secretion characteristic of drone or worker cells, and this determines the kind of cell made and consequently the nature of the secretion poured out over the egg when laid. The two sexes are equally balanced in the newly-laid egg and the workers pour out a secretion from one of two glands in the head, the secretion from one causing the egg to develop into a male; of the other, into a female. The secretion of the "salivary" gland of the workers is comparable to a sexual act and probably produces similar emotions. Sex cannot be determined by mere size of cell or by food. These glands have been observed in the queen in a rudimentary state and in wasps. It is further claimed that experiments (performed by Dickel himself) on hybrid hives have clearly shown paternal characteristics in male offspring.

Weismann and his students, Petrunkewitsch and Paulcke, have pointed out the errors in this theory and, from work of their own, strongly reaffirm the view of Dzierzon, that sex is here determined by fertilization.

Other Cases of Parthenogenesis.

Classification.—Parthenogenetic development manifests itself in a variety of ways and many synonymous terms have been applied to the different kinds of parthenogenesis. The following classification will serve to make clear the relations of the different phenomena to one another and to show the synonymous terms used:

Parthenogenesis (Agamogenesis).

1. Partial.

Development to early cleavage or larva.

e.g., Vertebrates (?) and Echinoderms.

2. Complete—to adult condition.
   (*a*) Occasional—exceptional—Tychoparthenogenesis (Henneguy).
      e.g., *Bombyx mori.*
   (*b*) Normal—Isoparthenogenesis (Hatschek).
      (1) No Alternation of Generations.
         e.g., *Apis*, *Nematus.*
      (2) Alternation of Sexual and Parthenogenetic Generations—Heteroparthenogenesis (Hatschek), Heterogeny (Leuckart), Pseudoparthenogenesis (Spencer).
         e.g., *Aphis*, *Daphnia.*

The following classification of Complete Parthenogenesis is based on the sex of the resulting individuals:

1. Homoparthenogenesis (Henneguy), Complete Parthenogenesis (Spencer).
   One sex only produced from unfertilized eggs.
   (*a*) Arrenotoky (Leuckart), Androgenetic (Breyer).
      Males produced. *e.g.*, *Apis.*
   (*b*) Thelytoky (v. Siebold), Gynogenetic (Breyer).
      Females produced. *e.g.*, *Psyche.*
2. Heteroparthenogenesis (Henneguy), Mixed Parthenogenesis (Stein).
   Amphoterotoky (Taschenberg), Amphotoky (Lankester).
      Both sexes produced parthenogenetically. *e.g.*, Aphidæ.

An Alternation of Generations often accompanies parthenogenetic development, and in the literature considerable confusion occurs by a mixing of the terms. For this reason the following classification is given so that the occurrence of Parthenogenesis in relation to Alternation of Generations may be made clear:

Alternation of Generations (*Metagenesis* Owen).

1. Sexual Generation alternating with a Budding Generation.
   (*a*) Buds remain attached to form colonies.
      e.g., Medusæ and Polyps.
   (*b*) Buds separate.
      e.g., *Salpa.*
2. Sexual Generation alternating with Parthenogenetic Generation.
   Heteroparthenogenesis (Hatschek), Heterogeny (Leuckart).

3. Two Sexual Generations differing in form—Alloigony (Leuckart).
   (*a*) One free generation, one hermaphroditic and parasitic.
   e.g., *Rhabdonema*, *Allantonema*.
   (*b*) Seasonal Dimorphism.
   e.g., *Lophyrus pini*.

Pædogenesis or the parthenogenetic reproduction by larval forms is frequently met with (*e.g.*, Diptera). This term was introduced by v. Baer (1864), but unfortunately it has since been applied by Seidlitz (1872), Dilling (1880) and others to all cases of sexually mature larvæ, even though the reproduction be truly sexual. Thus they would include under this term the reproduction of Axolotl and of Gyrodactylus. v. Siebold (1869) used the term pædogenesis for the reproduction of the Strepsiptera, but in this case the sexually mature female is simply a degenerate adult and not a larval form as v. Siebold supposed, and the reproduction is sexual as far as the evidence at present goes. To aid in the clearing up of this confusion of terms, Taschenberg (1892) suggests the term Proiogony for all cases of sexually mature larvæ, so that the word Pædogenesis can be used in its original and proper meaning. Chun (1892) uses the term Dissogonie for cases like those found by him in *Cydippe*, where the same individual at different stages of development is sexually mature, and these stages are separated by a metamorphosis.

The word Pseudoparthenogenesis has been applied by some writers to cases in which the eggs are fertilized from a seminal receptacle (*e.g.*, female eggs of *Apis*), and in which copulation does not take place for each egg. The use of such a word is unfortunate since it implies that there is a similarity to parthenogenesis, while there is really a very fundamental difference.

Insecta.

Hymenoptera.—Besides the case of the Honey Bee referred to at some length on preceding pages, numerous other cases of parthenogenesis occur among the Hymenoptera.

Tenthredinidæ.—The first case described in this family was that of *Nematus ventricosus* (=*N. ribesii*) by Robert Thom (1820) who wrote: "The insect is male and female, but the ova of the female produce caterpillars, even when the male and female flies are kept separate. How long this offspring would continue to

breed has not been ascertained. . . . There is some reason to suspect that there is a connection between male and female caterpillars, for I have frequently observed them twisted together for some time after they have ceased eating, and a little before they cast their skins to go into the pupa state." This same form was investigated by Kessler (1866) and especially by v. Siebold (1871). Other papers on this family are those of Cameron (1885), Fletcher, (1880), v. Stein (1881–83) and Brischke (1887). Taschenberg (1892) gives a long list of members of this family for which parthenogenetic development has been recorded. The various members of the group afford examples of Arrenotoky, Thelytoky and Amphoterotoky.

Cynipidæ.—In this family many species are known only from females, males being entirely absent or very rare. Leon Dufour (1841) found no males in two hundred individuals of *Diplolepis gallæ tinctoriæ* collected, and Hartig (1843) no males in nine thousand examples of *Cynips divisa.* Osten-Sacken (1861) attempted to explain this by claiming that the males live in different galls from the females and are not recognized as the same species. Such a dimorphism is known for some Cynipidæ and it is probably true for many more. Taschenberg (1892) gives a list of nineteen cases in which males and females have been described as different genera and are now known to be but cases of sexual dimorphism. *Cynips quercus-cærculata* (Osten-Sacken) which produces a large gall in the autumn, in the spring of the next year lays eggs which produce galls of another form, originally named *C. q. spongifica.* The autumn brood of this *Cynips* consists of parthenogenetic females, while the spring brood is of both males and females.

Neuroterus lenticularis produces galls of a certain form on the under side of oak-leaves and the flies appear in the early spring. These deposit their eggs on the buds of the oak which produce galls unlike those of the autumn and the fly, of both sexes, which emerges from the second gall has been referred to a separate genus (*Spathegaster baccarum*). This in turn lays eggs which produce the original form of *Neuroterus*, all females.

In the families of Ants and the family Vespidæ parthenogenesis similar to that of *Apis* is very common, as is also true for other species of the family Apidæ. The best known cases are those investigated by v. Siebold (1870–71), *Vespa germanica* and *Polistes gallica.*

Andrenidæ.—In *Halictus*, according to Fabre (1880), a mixed brood results from the development of the unfertilized eggs, Amphoterotoky. Cf. Perez (1895).

Ichneumonidæ.—v. Siebold (1884) describes Thelytoky for *Paniscus glaucopterus*.

Chalcididæ.—Adler (1881) describes an alternation of generations and probable Arrenotoky for *Pteromalus puparum*.

COLEOPTERA.—Few cases of parthenogenesis are recorded for this sub-order, Osborne (1879–81) and Jobert (1882) being the only observers who record such phenomena. The cases recorded are *Eumolpus* (*Adoxus*) *vitis* and *Gastrophysa raphani* (*Gastroidea viridula*). Osborne considered parthenogenesis in *G. raphani* to be as frequent as in *Nematus ribesii*, while Jobert suggests that the form studied by him (*Adoxus*) is hermaphroditic. v. Siebold (1869) described pædogenesis for the Strepsiptera, the females of which are wingless and worm-like with a flattened triangular head and live in the abdomen of bees and wasps. The female is viviparous, producing hundreds of young, but is not a larval form at the time of reproduction, and there is no evidence that fertilization does not take place.

LEPIDOPTERA.—In *Bombyx mori* occasional parthenogenesis has been observed. Constans de Castellet (1795) first recorded this, and it was confirmed by Herold (1838) and Leuckart (1855). v. Siebold (1856) and a pupil Schmid got both sexes from unfertilized eggs. Verson (1873) showed that reproduction in this case is generally sexual and (1888) claimed that parthenogenetic development for this species is usually partial. Tichomiroff (1886–91) produced partial parthenogenesis in this form by mechanical excitement (1886) and by putting the eggs in 65 per cent. sulphuric acid for two and one-half minutes (1889). Nussbaum (1898) found that two per cent. of the eleven hundred unfertilized eggs examined showed segmentation but never hatched, and in similar observations on the eggs of *Parthesia* and *Liparis* he did not get cleavage in any case.

In *Solenobia triquetrella*, *S. lichenella*, and *Psyche helix* true Thelytoky occurs and we have a succession of parthenogenetic females, and only occasionally in *P. helix* is a male produced.[1] Much of the early work on parthenogenesis was done on Lepidop-

[1] Described by Claus, 1866. No males are known for Solenobia.

tera, some of the workers being Réaumur (1738), Pallas (1767), Degeer (1771), Kühn (1775), Schiffermüller (1776), Schrank (1776 and 1802), Scriba (1790) and Reutti (1810). v. Siebold was at first (1849) inclined to doubt the existence of parthenogenesis in these species, but in 1856 published the results of elaborate experiments in which it was fully proven. Speyer (1847), Wocke (1853) and Reutti (1853) reached similar conclusions, and Leuckart (1858) examined the females of *Solenobia* and found no spermatozoa in the seminal receptacle, although there was a micropyle on the egg. Hartmann (1871) raised many successive generations of individuals parthenogenetically.

HEMIPTERA.—The first to investigate the reproduction of Aphids was Leeuwenhoek (1695). He found that the young are produced vivaparously and that there are few males, and Réamur (1737) from like observations, on theoretical grounds, held that they are protandric. Bonnet (1745), who generally gets the credit of having first observed the reproduction of the group, raised nine generations of viviparous females in two and one-half months in summer, and in the fall males appeared which copulated with the females, and eggs were laid which hatched out in the following year. Degeer (1773) worked on *Lachnus pini* and *Aphis rosæ*, and concluded that sexual individuals could be entirely done away with by keeping the insects protected from cold, and in this he was confirmed by Kybér (1815), who raised fifty successive generations of viviparous individuals in four years. Most of these earlier workers thought that the viviparous individuals were larval forms, which would afterward develop into the oviparous individuals.

Similar experiments led Duvau (1825) to believe that the oviparous and viviparous individuals are entirely distinct and that they never have the power of reproducing in both ways, and later Morren (1836), for *Aphis persicæ*; Ratzeburg (1844), for *Aphis oblonga*, and Newport (1847), for *Aphis rosæ*, came to similar conclusions.

Dufour (1841) repeated the experiments of Bonnet and referred the reproduction of *Diplolepis gallæ tinctoriæ* to "spontaneous or equivocal generation, in which impregnation is in no way concerned." Morren (1836) also believed in this spontaneous generation and thought that Aphids are developed in the body of the virgin parent: "Comme chez quelques entozoaires par individualisation d'un tissu precédément organise."[1]

[1] Page 90, *loc. cit.*

v. Siebold (1839) examined the viviparous and oviparous females and found that there is no appreciable difference between the ovaria of the two, but that the former lack a receptaculum seminis, and are, therefore, incapable of copulation. In the former point he was confirmed by Owen (1849), but not by Steenstrup (1842), who insisted that the viviparous individuals do not have ovaries but a well-developed uterus; to these he gave the name "Ammen" or nurses.

A most important step in advance was made by Steenstrup (1842) when he introduced the idea of an Alternation of Generations in Aphid development, as well as for other forms. He and Carus (1849) concluded that the viviparous development is comparable to the Cercaria stage of the Fluke worm, and the theory, first suggested by Duvau (1825), that here we have two generations, each distinct from the other, but each in turn giving rise to the other, was strengthened. Steenstrup would not, however, admit that the viviparous development is at all comparable to the oviparous, for he wrote: "No true ovary has been discovered in the larval and larviparous Aphids, but the germs, as soon as they are perceptible, are situated in organs which must be regarded as oviducts and uteri."[1]

About this time the theory of Dzierzon (1845) was advanced for the parthenogenetic development of the drone eggs of the Honey Bee, but such an explanation was not accepted for Aphids, and even v. Siebold, in his celebrated paper, "Wahre Parthenogenesis bei Schmetterlingen und Bienen" (1856), although advocating parthenogenesis for the forms on which he worked, refused to admit it for plant lice, for he wrote: "Die viviparen Blattläuse keine Weibchen sind, welche sine concubitu im jungfräulichen Zustande entwicklungsfähige Eier hervorbringen, sondern geschlechtlose mit Keimstöcken ausgestattete Ammen-oder larvenartige Individuen, welche von den wirklich jungfräulichen Blattläuse-Weibchen himmelivert vorschieden sind."[2]

Owen (1849) applied the term Parthenogenesis to the development of Aphids, not in the sense in which it is now used, but as an equivalent of the term Alternation of Generations used by Steenstrup. Owen thought that the fertilization which takes place in

[1] Page 112, English translation.
[2] Page 14, *loc. cit.*

the fall was enough to furnish what he designated as "spermatic force" for the development of the numerous summer generations. "In the vertebrated and higher invertebrated animals only a single individual is propagated from each impregnated ovum. Organized beings might be divided into those in which the ovum is uniparous and those in which it is multiparous. This is the first and widest or most general distinction which we have to consider in regard to generation, and in proportion as we may recognize its cause will be our insight into the true condition on which Parthenogenesis depends." [1]

The next step in advance was made when it was discovered by Leydig that there is no observable fundamental difference between the ova of the viviparous and oviparous females. There is, of course, a great difference between the summer eggs which develop parthenogenetically and the winter eggs as to size and amount of yolk, but this is only such a difference as may be observed between the eggs of various species and in no way argues for a dissimilar origin. This, then, put the Aphid development in the same class with that of *Solenobia*, *Apis* and other species known to develop from unfertilized eggs; but so firm a hold had the idea that fertilization is necessary to the development of a true egg that Huxley (1858) and Lubbock (1857) gave the name "Pseudova" to the eggs of the viviparous females. From this time on it has been held that the viviparous development was a case of true parthenogenesis.

The Alternation of Generations and parthenogenetic development is further complicated by other factors. Thus in Aphids the last of the viviparous generations is a generation known as the *sexupara*, the parthenogenetic and viviparous descendants of which are winged males and wingless females. After copulation, these females lay the fertilized winter eggs. This cycle of development is still further complicated by migrations from one plant host to another. A winged parthenogenetic generation frequently appears, and then may migrate to a different plant there to reproduce itself, and in a later generation return to the original host (Lichenstein, 1875). These generations have been distinguished by Blochmann (1889) as emigrants, alienocolæ and remigrants. Thus *Pemphigus terebinthi* (Derbes, 1872) gives rise to a wingless parthenogenetic generation (*a*), which produces another winged

[1] Page 62, *loc. cit.*

generation (*b*), the emigrants. This generation goes to another plant and produces a third generation (*c*), the remigrants and sexupara, which hibernate, return to the original plant and produce the small wingless sexual forms (*d*), the "sexuales." Here the sexual generation occurs in the spring rather than in the fall, as in most other forms.

Similar conditions are found in the Chermetidæ, except that here the parthenogenetic generations as well as the generations arising from fertilized eggs are oviparous (see the works of Blochmann, Dreyfuss and Cholodovsky). In *Chermes abietis* the fertilized egg develops into a wingless parthenogenetic female (*a*), which hibernates at the base of the buds of *Abies balsamia* and produces galls. In the spring winged females (*b*) are produced, which migrate to the Larch and give rise parthenogenetically to a wingless generation (*c*), which hibernates under the bark. These alienocolæ in the following spring produce parthenogenetic winged females (*d*), remigrants or sexupara, which return to *Abies* and produce wingless males and females, the eggs of which produce the first generation named in the cycle. Here two years is required to complete the cycle.

In *Phylloxera quercus* (Lichenstein) the winter eggs are laid on *Quercus coccifera* and give rise to females, which produce parthenogenetically a winged generation (emigrants), which fly to *Q. pedunculata* and *Q. pubescens*. These parthenogenetically produce several generations of alienocolæ and finally produce the remigrating sexupara, which return to *Q. coccifera* and produce the sexual generation. In *Phylloxera vastatrix* the generation which develops from fertilized eggs laid under the bark of the grapevine wander to the roots and there produce parthenogenetically several generations of wingless forms, which cause the swellings of the roots. This series is closed by the production of winged sexupara which go to the surface and swarm. Their eggs, which develop without fertilization, vary in size according to the sex, and the resulting individuals again begin the cycle.

The physiological difference between fertilized and parthenogenetic eggs is often accompanied by difference in appearance. The parthenogenetic ones are generally small and poor in yolk and develop in a shorter time and in greater number, while those requiring sexual cell union are larger and develop more slowly. The former are called summer eggs or *Subitaneier;* the latter winter

eggs or, because of the fact that they remain undeveloped for some time after fertilization, *Dauereier* or retarded eggs.

DIPTERA.—This group furnishes some excellent examples of pædogenesis or pædoparthenogenesis, and the phenomena as shown in various genera grade into each other in such a manner that it becomes evident that no line of demarcation can be drawn between parthenogenetic development from eggs laid by adult females and pædogenesis. While it is perhaps well to make a distinction between the phenomenon of parthenogenesis as exhibited by eggs of adult females and the same phenomenon as shown by the eggs of females which have not yet reached the last or adult stage of their development, yet the fundamental principle is the same in each case and it is not well to put too much stress on the degree of development of the parent when such a distinction tends to hide the similarity of the two kinds of reproduction.

Wagner (1862), in a Russian paper, reported cases of fly *larvæ* which bring forth young viviparously and, as he thought, from a transformation of the fat body, the parent dying at the birth of the offspring. This was in opposition to every principle of zoology and was, of course, not accepted on account of the announced method of formation of the embryos. In a short time, however, v. Baer (1863) and Meinert (1864) confirmed Wagner in all points except the source of the young, and later Wagner came to the conclusion that the viviparous young, are developed from true eggs. These conclusions were confirmed by Ganin (1865). The forms worked on were *Miastor* and *Cecidomyia*.

The next phenomenon of the series is that shown in *Chironomus* (Grimm, 1870). Here the *pupæ* lay eggs which develop parthenogenetically. This case comes nearer to what is observed in Hymenoptera, and the next step, which completes the series, is that of *Chironomus Grimmii* (Schneider, 1885) in which the *imago* lays parthenogenetic eggs.

Without going into a discussion of other forms on which work has been done, it will be evident that here we have a series of cases in which the Cecidomyidæ have reached the most specialized condition, they being able to bring forth young viviparously from a larval parent without waiting for the parent to reach the adult condition before acquiring sexual maturity. The case reported by Grimm for *Chironomus* would then appear to be one in which this power of bringing forth young very soon had not been so com-

pletely acquired, since the female must here wait until she reaches the pupal stage before she is sexually matured, and then she has not the power of viviparity but must lay her eggs; viviparous reproduction being undoubtedly an advantage to a species from the standpoint of increasing their numbers. It would then seem that some Diptera have not only acquired the advantage of parthenogenetic development but have shifted this power back to the pupa, or even larva, so that they may still more profit by this specialized method of reproduction.

ORTHOPTERA.—The development of eggs without fertilization has recently been described for this group by several persons. Dominique (1899) obtained parthenogenetic development (thelytoky) in *Bacillus gallicus*, while Heymons got one male to every twenty to twenty-five females in the parthenogenetic offspring of *B. Rossii*; and Azam (1898) and Stadelman (1898) also got some parthenogenetic individuals in the last-named species. Bolivar (1897 and '99) got three cases out of ten in which isolated larvæ of *Heptynia hespanica* produced eggs which developed; but he is not sure that they were not fertilized, although Pautel describes parthenogenesis as occurring in this species [cf. also Brunn (1898)].

From the evidence now at hand it would appear that parthenogenesis in this group is exceptional.

CRUSTACEA.

Next to plant lice, our earliest knowledge of the development of unfertilized eggs was for cases among the Crustacea. Schäffer (1755) described the development of eggs from unfertilized females of Daphnids, and by isolation he succeeded in producing several generations without fertilization and described this as being similar to what was known to take place in Aphids. Ramdohr (1805) raised ten successive generations parthenogenetically, and Jurine (1820) also confirmed the work. Ramdohr, however, did not look on these forms as true females but as hermaphrodites. These observations were on summer eggs, there being practically the same difference in this group as we find in Hemiptera. The summer eggs as in Aphids develop parthenogenetically, while the winter eggs require fertilization.

v. Siebold (1856) stated that he thought that *Apus cancriformis*, *Limnadia gigas* and *Polyphemus oculis*, in which no males had been

observed, showed true parthenogenesis, and Leuckart (1857) expressed the same opinion for *Daphnia*. In 1858 males of *Apus* were discovered and were examined by v. Siebold and he thus learned that some broods can go on developing parthenogenetically, like the Lepidoptera (Thelytoky), while other broods have both sexes present. For several years he watched a small pool near Munich, and at one time with great care removed every individual and found no males in 5796 individuals. In pools where both sexes occurred the proportion of males and females was very variable, and v. Siebold was led to believe that in these cases the males are disappearing, since from examinations in different years he found a constantly increasing proportion of females.

v. Siebold foresaw the objection that males might have been present previous to the examination of the pools, and consequently examined the male genital organs and spermatozoa and then the ovaries and their development. He never succeeded in finding any spermatozoa in the female genital organs. The structure of the ovum made this observation decisive since he found a hard egg-shell formed in the uterus and no micropyle, so that if fertilization takes place it must be before the egg is laid. Brauer (1872) found that fertilized eggs of *Apus* produced males.

Several other groups of Crustacea show a similar method of development, but do not differ to any extent from *Apus*. Parthenogenesis has been observed in the Phyllopods, Ostracods and Copepods, but in none of the Malacostraca.

In *Artemia salina*, Joly (1840) found no males in 3000 individuals examined and explained this as due to hermaphroditism, but Gerstäcker (1867) and especially v. Siebold (1871) established this as a case of true parthenogenesis. In *A. Milhausenii*, Fischer v. Waldheim (1834), Rathke (1836) and Fischer (in Middendorf's *Reise, Zoologie*) found that males are rare, and the same is true for *Limnadia Hermanii*, both cases being explained like that of *A. salina*. The maturation of the parthenogenetic egg of *A. salina* (Brauer, 1893) is discussed in another place.

A case worthy of note is that of *Leptodora hyalina*, a Daphnid, in which the winter eggs follow the usual plan of Crustacean development and form a Nauplius stage, while the summer eggs develop directly into an adult form with all limbs present. This is one of the striking cases which indicate that parthenogenesis is acquired

where it is desirable to produce individuals quickly, since here the larval stages are omitted.

Unisexual and bisexual generations alternate with each other in various ways in Crustacea and the mode of the alternation is remarkably related to their environment, as has been shown by Weismann. According to whether the causes of destruction visit a colony once or several times during the year we find forms which have one or several cycles of parthenogenetic and bisexual generations, and finally species are known which show no alternation. These are designated as monocyclical, polycyclical and acyclical respectively.

Trematodes.

The development of the *cercaria* and *redia* stages of *Distomum* has been the subject of much discussion for a long time. Leuckart, in his *Parasiten des Menschen*,[1] gives an historical account of our knowledge of the development of these forms up to the date of its issue (1879). That there is a development without fertilization is admitted on all sides, but the question as to whether the *rediæ* develop from true germ cells is still a point of dispute. Leuckart (1882) and Schwarz (1886) consider this as a true case of pædogenesis, the internally developing *rediæ* being looked on as arising viviparously from cells of the germinal epithelium. On the other hand, Wagener (1857) and Biehringer (1885) maintain that they arise from cells of the body wall and are therefore not produced sexually but by budding. Korschelt and Heider, in their *Text-Book of Embryology* (1890), do not consider this difference of great significance. "[2]This difference does not seem to us to be important, for we have already seen that the parietal cells and the germ cells are embryologically of the same origin. In a portion of the cells of the body wall even, a differentiation into separate histological elements appears not to have taken place, and for this reason they may continue to develop in the same way as the real germ cells. In harmony with this view is the statement of Thomas,[3] who derives the rediæ from both the germ cells and the cells of the body wall; if the supply of the former were exhausted, then the latter might take their place."

[1] II. Bd., p. 488 and following pages.
[2] Page 183, Vol. I, English Translation.
[3] Thomas (1883).

If such an explanation be the true one, then it would appear that the difference between sexual and asexual reproduction is not so great as is generally supposed.

Rotifers.

The phenomena of development are very complicated in the Rotifers. In most cases the males differ from the females in being smaller and in the absence of an alimentary canal. The eggs are of two kinds, the same difference being seen here between summer and winter eggs as in Aphids. Cohn (1856–58) first worked out the development of this group and found that the winter eggs are fertilized, while the summer eggs are not. Huxley (1857) looked on these summer eggs as sexless buds, but the work of Joliet (1883), Plate (1884–85) and Maupas (1889–90) established this as true parthenogenesis. Here, as in Aphids and Daphnids, the males appear at the beginning of an unfavorable period in the life cycle.

Under the subject of the Maturation of Parthenogenetic Eggs the work on Rotifers is mentioned, and the results there recorded are the most interesting features in connection with the phenomenon of parthenogenesis in the group. The principal point of interest is that the male and female eggs behave differently during their maturation, although eggs of both sexes have the power of development without fertilization.

Lauterborn (1898) found that the Rotifers could be classified into three groups as follows: (1) Species found all the year around; (2) Species found in summer, and (3) Species found in winter. In the summer and winter species the fertilized and yolk-laden eggs appear after a long series of parthenogenetic generations; they are monocyclic. In the species found during all seasons of the year the appearance of the males and the consequent fertilized eggs may occur twice or more times during the year; they are polycyclic. Probably some species are acyclic; that is parthenogenetic forms can be produced indefinitely and "winter" eggs are unknown. The determination of the appearance of males in Rotifers has been variously explained, the amounts of heat (Maupas) and nutrition (Nussbaum) being often considered as the causes. Lauterborn concludes that such external causes do not fully explain this but that some internal factor is the principal cause. The cyclic appearance

of fertilized eggs recalls the periodic occurrence of conjugation among protozoa, and according to Wesenberg-Lund (1898) and Lauterborn (1898) senility is an important factor in determining the length of the cycle. That lack of nutrition and the appearance of a senile condition are intimately connected seems very probable, if we may be permitted to reason from analogy on work done on *Paramœcium caudatum*. Calkins, in a recent paper,[1] records that he has been able to raise Paramœcia for six hundred and sixty-five generations by fission, and they were rejuvenated five successive times by change of food rather than by conjugation, or as he expresses it "parthenogenetically."

Vertebrates.

The question as to whether there is a parthenogenetic development among any of the Vertebrates is one which has been much discussed. If there are any cases at all they are cases of partial parthenogenesis, since in no case is it claimed that development goes farther than the first few cleavage stages. Bonnet (1899) discusses at some length the evidence on this subject, and since he has so well reviewed the literature it is not necessary to do more here than state the general conclusions to be reached from a survey of what has been reported.

Eggs of *Amphioxus lanceolatus* (van der Stricht, 1895) show a tendency to divide if not fertilized. This is not pronounced.

Cleavage of unfertilized eggs in the ovary are reported among the Gadidæ by Burnett and Agassiz (cited by Oellacher, 1869), for the Sturgeon by Bellonci (1885), and for the Trout by Oellacher (1872). Oellacher attributed this to the retention of the eggs for too long a time.

For the Frog and other Amphibia many investigators have claimed parthenogenetic cleavage, since it frequently happens that eggs which pass from the female when she is not copulating with a male show cleavages, but these are generally irregular. Pflüger (1882) was able to show rather conclusively that such cases are due to fertilization of these eggs by spermatozoa in the water which are nearly dead, and consequently the development is short and irregular. Kulagur (1895) and Bataillon (1900) did some experiments

[1] Calkins, Gary N., 1902, "Studies on the Life History of Protozoa," III. The Six Hundred and Twentieth Generation of Paramœcium caudatum, *Biol. Bull.*, III, No. 5, pp. 192–205.

on artificial parthenogenesis, but these must not be considered as arguing for a true natural parthenogenesis.

Among Reptiles, Strahl (1892) reports irregular parthenogenetic cleavages.

In the Birds, the evidence for a parthenogenetic development is perhaps the strongest of that for any vertebrates. It frequently happens that a blastoderm is formed on an egg which is apparently not fertilized. Cases of this kind are found in the Chick (Coste, 1859; Oellacher, 1869; Koelliker, 1879, and others), in the Turtle Dove (Motta Maja, 1877; cited by Duval, 1884), and for several other birds (Duval, 1884). Balfour (1880) pointed out that care must be exercised in passing judgment on these cases, since it is known that spermatozoa can live for a considerable time in the female and that possibly these are really cases of fertilized eggs. This is entirely upheld by the later work of Lau (1895) and Barfurth (1895), who show that eggs from virgin hens do not show cleavage in the same way as do those from hens which have copulated with a cock even a considerable time before. In eggs from virgin hens the blastomeres do not have a cellular character, since all but a few lack nuclei, and when nuclei are present they do not divide mitotically. The blastoderm lacks all power of assimilation, the blastomeres are irregular and the whole shows no thickening at the posterior end. There is never a segmentation cavity. Lau and Barfurth looked on such cases as due to a physico-chemical process, caused partly by evaporation and partly by coagulation of the protoplasm. Cases in which the female has previously copulated would then appear to be similar to those of the frog, in which there is a fertilization accomplished by a partially devitalized male cell.

Even in Mammals, cases are recorded of the cleavage of the egg while still in the Graffian follicle. Janosik (1896) reports several cases (Rabbit) in which a cleavage has taken place, a semblance of a cleavage cavity formed and the whole mass has broken away from the membrana pellucida as in normal development; but the phenomenon is so evidently connected with disintegration from the very beginning that it must not be considered as parthenogenesis.

The question as to whether Dermoid cysts are due to the parthenogenetic development of an egg has received a great deal of attention, and the exceptional case reported by Répin (cited by Duval, 1895) would point strongly to such an explanation as the true one. This cyst had four limbs and terminated in a kind of

head composed of bones arranged in a cube and surmounted by three teeth. The bones of the feet and hands were perfectly recognizable. There was no alimentary canal in the body, but beside it was a tube which histologically resembled an intestine.

It would appear then that these phenomena are not true parthenogenesis, unless it be that we consider that as the explanation of the cysts. The fact that the cleavages do not follow the regular plan of fertilized eggs would not of itself bar these cases as being classed as a true development from an unfertilized egg, since in other cases, where there is undoubtedly a parthenogenetic development, the method of growth differs from that of the fertilized egg of the same species, *e.g.*, *Leptodora*. Neither must we bar these cases because the development goes but a short distance, since the life of an individual must be considered as beginning with the unsegmented egg, and if that egg shows a power of development without fertilization, that phenomenon is as truly parthenogenesis as if an adult animal resulted. However, since in these cases we find the segmentation of the egg to be more in the nature of a physico-chemical change than a true cleavage, we must consider it as entirely different, and we must, of course, bar out all cases in which the proper amount of care has not been taken in proving that fertilization has not been affected by a half-dead spermatozoon.

Arachnids.

But one well authenticated case is known to exist in Spiders (Campbell, 1883). Parthenogenesis in this group has recently been discussed by Montgomery (1903), and it is not necessary to repeat his discussion since it has been done so recently.

In many other animals there is a marked tendency for the mature egg to go on dividing if fertilization does not take place. This is often observed in Echinoderms, some Annelids and Molluscs. Such eggs never develop beyond a very early stage, and only a very small proportion of eggs show this cleavage. A point worthy of note is that these very forms are the ones which have yielded the best results in work done in Artificial Parthenogenesis, and the explanation which seems to follow from this is that such eggs normally require a very small amount of stimulus from the male cell, and the addition of some chemical to the water is enough to take the place of the male stimulus. In fact the results of artificial

parthenogenesis differ from what is normally found only in the greater proportion of parthenogenetic eggs.

The Maturation of Parthenogenetic Eggs.

The main point of interest in parthenogenesis is perhaps that of the maturation of the parthenogenetic eggs, on account of its general bearing on the theory of fertilization and on account of its support of the theory of the individuality of chromosomes.

Minot (1877), in an article on the theoretical meaning of maturation, suggests that parthenogenesis may be due to failure to form polar bodies, and since the entire mass of chromatin remained in the egg it would be hermaphrodite and capable of development without the addition of any chromatin from the male cell. Balfour (1880) follows out the same line of thought in suggesting that the function of forming polar bodies has been acquired by most ova to prevent parthenogenesis, and van Beneden (1883) held a nearly similar view.

Weismann (1886) found that one polar body is given off in the case of *Polyphemus* (Daphnid), and he later determined the same thing for parthenogenetic Ostracodes and Rotifers.[1] Blochmann (1888) found in Aphids that one polar body is given off in the case of eggs which develop parthenogenetically, while two are produced in eggs which require fertilization. Weismann was thus led to the view that the second polar body is of special significance in parthenogenesis. In insects (Blochmann and others) the polar bodies are not thrown out of the egg as in most other animals, but the chromatin masses remain embedded in a vesicle in the protoplasm of the egg, near the periphery, and are called "polar nuclei."

Boveri (1887) found in *Ascaris megalocephala* that the second polar body might remain in the egg (as is normally the case in insects) and give rise to a nucleus indistinguishable from the pronuclei. He, therefore, suggested that parthenogenesis might be due to the retention of the second polar body in the egg and its use as a male pro-nucleus.[2] "The second polar body would thus, in a certain sense, assume the rôle of the spermatozoon, and it might

[1] Compare Lenssen (1899), Erlanger u. Lauterborn (1897) and Mrazek (1897).

[2] Boveri (1887), p. 73.

not without reason be said: Parthenogenesis is the result of fertilization by the second polar body."

This conclusion was in part confirmed by Brauer (1893) on the parthenogenetic egg of *Artemia salina*. There are two types of maturation in parthenogenetic eggs occurring in the same animal, one in accordance with the idea of Boveri and the other not irreconcilable with it. For a brief description of the two methods in *Artemia* the statement of Wilson[1] is quoted:

"In both modes typical tetrads are formed in the germ-nucleus to the number of eighty-four. In the first and more frequent case but one polar body is formed, which removes eighty-four dyads, leaving eighty-four in the egg. There may be an abortive attempt to form a second polar spindle but no division results, and the eighty-four dyads give rise to a reticular cleavage-nucleus. From this arise eight-four thread-like chromosomes and *the same number appears in later cleavage stages.*

"It is the second and rare mode that realizes Boveri's conception. Both polar bodies are formed, the first removing eighty-four dyads and leaving the same number in the egg. In the formation of the second, the eighty-four dyads are halved to form two daughter groups, each containing eighty-four single chromosomes. *Both these groups remain in the egg and each gives rise to a single reticular nucleus, as described by Boveri in Ascaris. These two nuclei place themselves side by side in the cleavage figure, and give rise each to eighty-four chromosomes, precisely like two germ-nuclei in ordinary fertilization.* The one hundred and sixty-eight chromosomes split lengthwise and are distributed in the usual manner, *and reappear in the same number in later stages.* In other words, the second polar body here plays the part of a sperm-nucleus precisely as maintained by Boveri.

"In all individuals arising from eggs of the first type, therefore, the somatic number of chromosomes is eighty-four; in all those arising from eggs of the second type, it is one hundred and sixty-eight. This difference is clearly due to the fact that in the latter case the chromosomes are single and univalent, while in the former they are bivalent (actually arising from dyads or double chromosomes). The remarkable feature, on which too much emphasis cannot be laid, is that the numerical difference should

[1] Wilson, *The Cell in Development and Inheritance*, pp. 281–284.

persist despite the fact that the mass and, as far as we can see, the quality of the chromatin is the same in both cases."

Blochmann (1889) studied the maturation of drone and worker eggs in *Apis mellifica* with the following results: The first polar nucleus is given off normally and remains undivided, but the second polar nucleus often appears to divide. The fact that these three nuclei are not, as in some cases, due to a division of the first polar nucleus is proven by the position of this nucleus, which is always found just under the surface of the egg and separated by some distance from the other two. The female pro-nucleus soon becomes vesicular in form and goes to the axis of the egg, where it forms a spindle and gives rise to the blastoderm cells. The polar nuclei change as in *Musca vomitoria*, but do not become vesicular in form, approach one another and are enclosed by a rather large vacuole of the superficial protoplasm, which is free from yolk. In this vacuole they break up into fine chromatin granules, which become scattered through the whole cavity of the vacuole. We may suppose that the contents are later removed from the egg. In fertilized eggs the ovarian nucleus undergoes the same divisions as the unfertilized.

Platner (1887) also found two polar nuclei in *Liparis dispar*, a parthenogenetic Lepidoptera. These two cases, the first two recorded, are not in accord with the previous views of Weismann, and in 1891 he sought to explain these cases as follows: "Das Kernplasma einzelner Eier einer Art das Vermögen des Wachsthums in grösserern Masse als du Majorität derselben besitze, oder, im Falle der Biene, jedes Ei besitze de Fähigeit, sein auf die Hälfte reducirtes Kernplasma, wenn es nicht durch Befruchtung wieder auf das Normalmass gebracht wird, durch Wachsthum wieder auf die doppelte Masse zu bringen."

Petrunkewitsch (1901), studying *Apis*, found that eggs laid by the queen in drone cells never showed any signs of having been fertilized. As in a fertilized ovum the first polar nucleus is separated by an equatorial division, in the second maturation there is a reduction of chromosomes to one-half. Similarly the first polar nucleus always divides with a reduction and the peripheral half is liberated and perishes. The restoration of the number of chromosomes in non-fertilized eggs probably occurs by a longitudinal splitting of the chromosomes, but with a suppression of the corresponding division into two daughter nuclei. The central half of

the first polar nucleus conjugates regularly with the second polar nucleus and forms a "Richtungscopulationkern," with the normal number of chromosomes. This nucleus in the drone egg gives rise by three divisions to eight cells with double nuclei. In fertilized ova and in drone eggs laid by fertile workers this nucleus forms a spindle, which either simply disappears or gives rise to a number of nuclei, one to four; but these always show disruption phenomena in the chromosomes and ultimately disappear. In a later paper the same author (Petrunkewitsch, 1902) asserts that the products of the Richtungscopulationkern ultimately become the testes of the adult drone.

Paulcke (1899) found that in drone eggs there are four groups of chromosomes. Of these two seem to be the result of division of the first polar nucleus, one of the second polar nucleus and the fourth the egg nucleus. In twelve eggs examined from worker cells, fifteen minutes after they were laid, eight show sperm nuclei with their radiating systems. In eight hundred drone eggs examined no sperm nuclei were seen, but in three cases dark corpuscles were observed, which might have been sperm nuclei. In fertile worker eggs there were no indications of male pro-nuclei.

Mrazek (1897) and Erlanger und Lauterborn (1897) studied the maturation of the eggs of *Asplanchna*, a Rotifer. They find in this genus three kinds of eggs: (1) Parthenogenetic male eggs; (2) parthenogenetic female eggs, and (3) female eggs which require fertilization. When the female eggs requiring fertilization begin to develop, all other eggs begin to show cleavages of a degenerative nature, not like the normal cleavage, probably due to lack of nutrition (Mrazek). The parthenogenetic female eggs give off *one* polar body which never divides, while the parthenogenetic male eggs give off *two* polar bodies, the first of which normally divides. The female eggs requiring fertilization act like the parthenogenetic male eggs. In the parthenogenetic male eggs there is no indication of a union of the second polar body with the egg. The number of chromosomes is not determined (Erlanger und Lauterborn).[1]

Rückert (1895) found that in *Cyclops sternuus* the second maturation division cuts off a polar nucleus which remains in the egg, in a direction tangential to the second division figure. It does not

[1] See also Lenssen, 1899, "Contribution à l'Etude du developpement et de la maturation des œufs chez *l'Hydatina sexta*," *Cellule*, xiv, pp. 421–51, 2 pl.

form the primordial germinal cells. The first maturation division gives off a true polar body.

Causes of Parthenogenesis.—When we consider the difference in behavior of various parthenogenetic eggs during maturation and the differences in sex relations exhibited by the various groups, together with the wide range of the scattered cases where such development occurs, it is evident that parthenogenesis has had a separate origin in many places in the animal scale. All that is necessary in the maturation of a parthenogenetic egg is that the normal number of chromosomes shall be retained, and this may be brought about by the retention of the second polar body, fertilization by the second polar body or perhaps by the division of the chromosomes without the corresponding cell division.

In seeking for a cause for the appearance of parthenogenesis in a group of animals, it must be borne in mind that we are dealing with a phenomenon that to all practical purposes is like asexual reproduction, in that the species is not dependent on the union of the two sexes for the propagation of all the individuals of the species and that the causes for the appearance of asexual and parthenogenetic reproduction are practically identical, it being merely a question as to which method of agamic reproduction is most readily acquired by a given form when the necessity for such a thing arises. And, too, it is probable that the cause is not the same in all cases, since the environments and habits of the various forms possessing this power are so varied.

In the first place, parthenogenesis is generally associated with and probably caused by the necessity of the appearance of a great many individuals suddenly at a certain period of the year or of the life cycle. A large part of the forms exhibiting this method of reproduction are small short-lived animals which are represented during the winter or some adverse time in the life cycle by a very few individuals and, in order that the species may survive, are compelled to acquire some method of rapid agamic reproduction.

In the case of the Aphids the necessity is for females and we find thelytoky evolved; in the case of the Honey Bee the necessity is for males, so that the queens may not go unfertilized, and we find arrenotoky.

The question of economy enters very largely into the problem and is, in fact, almost identical with the preceding cause. In many

cases males are exceedingly rare at all times or except at certain seasons, and it is manifestly to the advantage of the species if it is able to survive without the presence of any but propagating individuals. Thus in the case of the bee, previously mentioned, it would be detrimental to the species to have countless drones feeding on the hive supplies during the winter; but for the purpose of increasing the hereditary influence, it is beneficial to the race to feed these males for a brief period when food is plentiful, in order that the fertilization may bring about the results known to come in all cases from such a union.

In still other cases the very habits of the animal make the chance of the occurrence of a sexual union too small, and in consequence the females have acquired the agamic methods of reproduction. The case of *Cercaria* offers a good example of this. If we accept the conclusions of Thomas, we see that here we get a transition from unisexual to asexual reproduction; and while these two processes are usually widely separated, yet the same difficulty of a sexual union may be looked upon as the probable cause of either phenomenon.

Determination of Sex.—From what has gone before we see that the problem of sex determination is very closely related to that of parthenogenesis, since parthenogenetic eggs so frequently show such peculiar sex relations. In some groups unfertilized eggs produce only males (arrenotoky), in others only females (thelytoky), while in some both sexes are produced (amphoterotoky). Taking as an example the Honey Bee, we know that the male eggs are not fertilized and the female eggs are; and reasoning from this, it seems true that the act of fertilization is the one determining factor, since no one has yet been able to find any other fundamental point of difference. As was shown under another heading, other explanations, such as differences in food or size of cell, have been advanced, but these have already been answered. Such work as that of Mrs. Treat (1873) on Caterpillars, of Born (1881) and Yung (1881) on Amphibia, and of Nussbaum (1897) on Rotifers would seem to indicate that lack of nourishment favors the production of males; but until we have more evidence we are perfectly justified in explaining these cases as simply survivals of the more fit sex under trying conditions, and cannot use them as arguing for theories like those of Dickel. In fact Cuénot (1899) did not succeed in verifying the results of Mrs. Treat, for he found that the proportions of

males and females remained approximately the same under all food conditions, and concluded that sex is determined in the ovary in insects.

There have recently appeared two papers of interest in this connection as offering suggestions for future work. Beard (1902) and v. Lenhossek (1903) conclude, on theoretical grounds, that sex is determined in the ovary of the mother and that there are in all cases two kinds of eggs, male and female, fundamentally differing from one another. Cases where such a state of affairs is known to exist are *Phylloxera*, *Dinophilus*, some Rotifers and possibly in *Raja batis* (Beard, 1902). According to these views, the sex is determined before leaving the ovary and consequently fertilization can have no influence, but at present we cannot look on these theories as more than interesting suggestions. It must be admitted that the determination of sex by fertilization is in direct opposition to what we know to be true for the great majority of animals where both sexes alike arise from fertilized eggs, and on *a priori* grounds the theory of Cuénot, Beard and von Lenhossek seems probable; but in this instance, as in all others in zoology, *a priori* reasoning is unsafe and we must wait for future investigations to decide whether there is any truth in these suggestions.

Comparison of Various Sex Relations.—As has been pointed out by several investigators, the process of fertilization has two distinct purposes—the giving of a stimulus for development to the mature egg, and the increasing of the number of hereditary tendencies of the offspring by giving it a blending of hereditary traits from two parents. The power of parthenogenetic development possessed by some animals takes the place of the stimulation of the male sex cell, since the ovum has given to it in the ovary enough vital force to go on dividing mitotically even after it becomes a part of another generation.

The second office of fertilization is simply omitted where fertilization does not occur, the advantage of agamic development more than balancing the advantage to be gained by the meeting of two lines of heredity. During ordinary maturation the egg gives off in its polar bodies one-half of the number of its chromosomes, the heredity carriers, and by the acquisition of an equal number from the male cell, carrying hereditary tendencies from the male parent, the original number is regained; and in order that the normal num-

ber may be retained in parthenogenetic eggs the reduction division is omitted, or in some other way the same result is accomplished.

This omission of a mixing of two lines of ancestry in the reproduction of a species is, if our conception of its significance is correct, a very important one. There is, however, a great difference in the extent of this omission in the various kinds of parthenogenesis. In Arrenotoky at every second generation a crossing occurs *of necessity*, since the females are produced from fertilized eggs. In Thelytoky, on the other hand, a mixing may be very rare or even entirely wanting; while in Amphoterotoky it generally occurs at regular intervals, as in the fall in Aphids. On the other hand, Thelytoky and Amphoterotoky are much more beneficial to a species from the standpoint of its propagation, since at no time is fertilization an absolute necessity, while in Arrenotoky fertilization is necessary for the production of the individuals which do the most toward the reproduction of the species. What the species loses in hereditary influences is more than made up by the increased advantage of these two most specialized kinds of parthenogenesis.

Pædogenesis.—If we look on parthenogenesis as a phenomenon which has arisen in various groups of animals so that the species may be reproduced rapidly and without so much dependence on chance, then it is but another step in the same direction to find this process shifted back to an embryonic stage of development so that the reproduction would not be delayed until the female reached the adult state. The same precocious segregation of the reproductive process is met with in forms which always require the fertilization of the egg, *e.g.*, *Amblystoma* (Axolotl), but in these cases the coincident phenomenon of parthenogentic development has not been necessary or desirable and we distinguish such cases as Proiogony. We may look on certain groups of the Diptera as in a transition stage, between the parthenogenesis like that observed in *Chironomus Grimmii* and that of *Miastor*. The species of *Miastor* has still further acquired the advantage of viviparity for the protection of the youngest embryonic stages, and seems almost to have reached the limit of advantage that a species can acquire for the propagation of its kind.

Partial Parthenogenesis.—As has been seen, eggs which have not been fertilized often begin to develop, but after a short time die. On this account it has been argued that such cases are not really parthenogenesis, since an adult or a sexually mature individual does not

result from the division. Such an argument cannot hold, since the fundamental principle involved is the same whether an adult results or not. We must consider that the life of the individual begins with the unsegmented egg, and if that egg has in itself the power of growth, manifested by cell division, then we must class it as a parthenogenetic egg; the only difference between such cases and examples like the male eggs of the bee being that there is in the former not so much of the power of unisexual development: it is merely a difference in degree and not in kind. It would seem that many of the cases of artificial parthenogenesis described are exactly similar to these cases of partial parthenogenesis, and that the change in environment produced artificially simply allows the egg the power of growth already in it to go on for a short time exactly as if fertilized.

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Stated Meeting, November 6, 1903.

President SMITH in the Chair.

A letter was read from the Schlesische Gesellschaft für Vaterländische Cultur, announcing the celebration of its one hundredth anniversary on December 17, and inviting the Society to send a representative to take part in the celebration. The Hon. Charlemagne Tower was thereupon appointed as such representative.

The decease was announced of Prof. Robert Henry Thurston, at Ithaca, on October 25, æt. 64.

Prof. Charles F. Chandler, of New York, read a paper on "The Electro-Chemical Industries at Niagara Falls."

Dr. Hans Goldschmidt, of Essen, Germany, explained his method for producing intense heat by his Thermite process.

A paper on "Dying American Speech-Echoes from Con-

necticut," by Prof. J. Dyneley Prince and Frank G. Speck, was read.

The Amendments to the Laws recommended by the Officers and Council, and duly proposed at the meeting of May 1, were adopted.

DYING AMERICAN SPEECH-ECHOES FROM CONNECTICUT.

BY J. DYNELEY PRINCE, PH.D., AND FRANK G. SPECK.

(*Read November 6, 1903.*)

It was my good fortune last summer to light upon a small and little-known reservation on the west bank of the Housatonic river, about two miles south of Kent, Litchfield County, Conn., occupied by sixteen Skaghticoke Indians. There are, however, about one hundred and twenty-five individuals not on the Reserve who claim tribal rights and relationship with this clan. The present Indians on the Reservation are mixed with a very appreciable percentage of negro and white blood and, according to their own account, came originally from various Connecticut tribes. The clan is said to have been founded in 1728 by one Gideon Mawehu (the modern family name Mawee, evidently a corruption of English Mayhew) who was either a Pequot or a Wampanoag. The ranks of the Skaghticoke settlement were swelled by refugees and stragglers from other tribes, until in 1731 they reckoned one hundred and fifty warriors. DeForest mentions among these foreign elements Potatucks from Newtown and Woodbury, Paugussets from the upper Housatonic territory, Salisbury and Sharon Indians originally from Windsor, besides Pequots, Narragansetts and Wampanoags. This mixture of race is evidenced in the various loan-words of New England origin pointed out below by Professor Prince.

From one man, James Harris, who claims to be a full-blood and whose skin certainly shows the dark red hue characteristic of the eastern Algic races, I was able to obtain in the old language twenty-three words and three connected sentences which Professor

Prince has analyzed below. Harris has only a vague and disconnected idea of the language. What little he knows he learned in early youth from his grandmother, one of the Mawee family, who, according to his statement, had a connected speaking knowledge of the ancient idiom. The present Skaghticokes are Indians more by tradition than fact, and with the single exception of Harris have little of interest to impart to Americanists.

The name Skaghticoke was originally pronounced *p'ska'tikuk*, *i. e.*, "at the forked river," from the same stem as Abenaki *p'skaôl'kwen* "branch"+the ending *-tukw*, which always means "river" in composition. The river-names Piscataquis (Maine) and Piscataqua (New Hampshire) are undoubtedly corruptions of the same word and have an identical meaning (see Prince, *American Folklore Journal*, 1900, pp. 125 ff.).

FRANK G. SPECK.

Thanks to the efforts of Mr. Speck, who is a student in my department in Columbia University, a modern form of the ancient Pequot-Mohegan dialect has been discovered in its last throes (see Prince and Speck, *American Anthropologist*, V, pp. 193–212). Mr. Speck has now found the still more scanty remains of another Connecticut language, that of the Skaghticokes, which, as will appear from the following exposition, is probably the last surviving remnant of the Delaware-Mohican idiom formerly used at Stockbridge, Mass., which was expounded by J. Edwards, Jr., and J. Sergeant (see Pilling, *Bibliography of the Algonquian Languages*, *s. v.* these authors). This Skaghticoke language is distinctly not a New England product, but came from the Hudson river region with that branch of the Lenni Lenâpe called Mohicans who settled at quite an early date on the site of Stockbridge, Mass. This *Mohican* idiom is only indirectly connected with the *Mohegan*[1]-Pequot language just mentioned, found by Speck at Mohegan, near Norwich, Conn. Perhaps the longest specimen of the Stockbridge Mohican tongue has been preserved in J. Quinney's *Assembly Catechism*, printed at Stockbridge in 1795. For the modern dialect of the Delaware Lenâpe, see Prince, *American Journal of Philology*, XXI, pp. 295–302.

[1] Note that *Mohican* and *Mohegan*, although both forms of the same word, are now used purely arbitrarily, the first to indicate the Hudson River Lenâpian Mohican clan, and the second to denote the Pequot mixed race at Mohegan, near Norwich, Conn.

The name Mohican=*Mŭhĭgănĭŭk* means "those dwelling on the tide-water" from Del. *makhaak* "great" and *hĭcan* "tide" (so Zeisberger) and plainly shows the geographical origin of the tribe. How this name came to be applied to the Pequot-speaking Mohegans of Mohegan, Conn., has been explained at length by us (*Anthropologist*, V, pp. 194 ff.). The Skaghticokes apparently do not know the name Mohican as applied to themselves.

It is curious and characteristic of human nature that a number of obscene words and phrases have survived with some accuracy in the mouth of Harris, Mr. Speck's informant. Such words would naturally live longer than others in the speech of the uncultivated, no doubt owing to their desire to speak of such subjects with secrecy.

It is quite plain that Harris has only a very imperfect knowledge of his grandmother's language, as he does not know the exact meaning of two out of the three sentences which he gave to Mr. Speck. His three connected sentences are as follows:—(1) *Wĭchŏwân tăpă-sŭk sŭkăgĭtĭnŏn* "hurry up to the hotel and get a drink." This seems to me to mean "come along, my friends, and we will have a drink." See *Glossary*, *s. v. kăgĭtĭnŏn*, *tăpăsŭk* and *wĭchŏwân*. (2) *Gŭkwĭ dĭâ n'pûmĭăs* "go sleep in the barn." This should be translated "you sleep there for the night." See *Glossary*, *s. v. gŭkwĭ* and *n'pûmĭăs*. (3) *Nŭnŭ'pă mănŭk* "lift up your clothes," said with obscene intention to a woman. This translation is correct, as will appear *s. v. nunu'pa* and *mănuk*. Finally, in this connection, it should be noted that Harris gives the incorrect forms *mămĭtŭkkŭ* for *mănĭtŭkkŭ* "devil"; *nĭskâhĭkĭăn* for *mĭskâhĭkĭăn* "cider," *n'pûmĭâs* for *n'pûwĭăs* "at night" and *tăpăsŭk* for *nĭtăpĕsŭk* "my friends" (see *Glossary*, *s. v.* these words).

The following words of the vocabulary are all Delaware Mohican: *gŭkwĭ* "thou sleepest"; *kwŏn* "yes"; *mămĭtŭkkŭ* for *mănĭtŭkkŭ* "devil"; *nĭskâhĭkĭăn* for *mĭskâhĭkĭăn* "cider"; *n'pûmĭăs* for *n'pûwĭăs* "at night"; *šâmût* "tripe"; *škŭk* in *škŭkărĭš* "snake"; *tăpăsŭk* for *nĭtăpĕsŭk* "my friends"; *tŭlĭpăs* "tortoise"; *wĭchŏwân* "come along." On the other hand, the following are probably New England loanwords from native Connecticut dialects akin to the Natick:—*chăkŭs* "negro"; *kănŭkwŏk*, pl. of *kĭnkăĭ* "private parts"; *mânŭk* "coat," "petticoat"; *rŭtĭg* "crushed corn"; *skwâ* "woman"; *sŭkkŭtăš* "succotash"; *tĭpĭ* "devil"; and *wănŭx* "white man." These loanwords are, of course, not surprising in

a language spoken in such an environment. The words *kwŏn* (=Del. *gohan*, but Natick *ôô*; Peq. *nux*=yes, so Stiles[2] in his vocabulary) and *špûti* "anus"=Del. *saputti*, would alone be sufficient proof of the Lenâpian character of the Skaghticoke idiom.

The Skaghticoke actually preserves the *r*-sound, so rare in modern Algic, in the words *rûtig* "crushed corn" and *škûkăriš* "snake." This is, so far as I am aware, the only modern instance of *r* in Algic, except in one dialect of the northern Cree. The *r* undoubtedly existed in Lenâpe at the time of the Old Swedish occupation of New Jersey and Pennsylvania (see Brinton, *The Lenâpe and their Legends*, p. 96 and, below, *s. v. rûtig*). As was the case among the Abenakis, this *r* changed to *l* at a very early date. In Rasles' dictionary of the ancient Abenaki, it is the regular rule to find *r* for modern *l*, but no living Abenaki pronounces *r* in the modern language. A most interesting parallel case is found in the Iroquois idiom spoken at the St. Regis Falls Reservation, where the Indians, instead of the *r* so common in Iroquois speech, now pronounce a thick medial consonant between *r* and *l*. Only the old people retain the primitive *r*-sound. My Iroquois informant tells me that a pure *l* will probably be pronounced by the next generation.

I must regard it as most fortunate for students of Algic philology that Mr. Speck has been able to collect these scanty and incorrectly preserved relics of a lost Algonquian language.

Glossary of Skaghticoke Words.

Chákûs "negro" is undoubtedly cognitive with Stiles's Pequot *auchugyeze* "blackbird" which must stand for *chokêsu*; cf. RW.[3] *suckêsu* "he is black" from *sucki* "black." The Del. *sukachqualles* "negro" is evidently a more distant cognate. I believe that *chákûs* was a New England loanword among these Skaghticoke Indians. The Aben. *mkazawigit* "negro" is perhaps cognitive with Natick *mûi*, the regular word for "black" in that language.[4]

[2] President Stiles was the author of a Pequot vocabulary, the MS. of which is now in Yale University Library. This glossary is extensively quoted in J. Trumbull's *Natick Dictionary*, Washington, 1903.

[3] RW denotes Roger Williams in his *Key into the Language of America*, which is a treatise on the Narragansett idiom.

[4] In indicating the pronunciation of the Skaghticoke words in this article, I have used the Italian vowel values, except *ú*=*u* in "but," and '=a short inde-

Gûkwí dīâ "you sleep there," from *k*=2 p.+*kawi* "sleep" (=Del. *gauwin*, Aben. *kawi*); *dīâ*=*talli* "there." Cf. Peq. *dâi*=*dali*, Aben. *tali*; *dali* after a vowel.

Kâgitínŏn "get a drink" (so Harris); I think the full form is *k'sûkâgitínŏn* "we (incl.) shall drink," see below *s. v. wíchŏwân*. *Kâgí* is the same stem seen in Peq. *gĕkíwŭ* "he is drunk" (Prince and Speck, *Anthrop.*, V, p. 206), but it also occurs in Del. *ki kakiwus* "thou art drunk."

Kănúkwŏk "private parts," a plural of *kinkâi* (*q. v.*), is probably a N. E. loanword from the same stem as Natick *kinukkinum* "he mixes, mingles"; cf. Nat. *kenugke* "among." In modern Peq. *kănúkĭ* "privates."

Kinkâi, given by Harris as "anus," undoubtedly means either "*membrum virile*" or "*pudendum femineæ*," *i. e.* "the mixer." It seems to be the singular of *kănúkwŏk*, *q. v.*

Kwŏn "yes" is undoubtedly identical with Del. *gohan* "yes" (Brinton, *Lenâpe Dict.*, p. 45, 2).

Mámîtûkkŭ "devil" is a corruption of *mánîtûkkŭ* "he is the (evil) spirit." Note in Natick *mattanitoog* "devils." In Del. *manito* is the regular word for "spirit, God"; cf. Aben. *madahôdo* "devil"; Peq. *muwundo* "God."

Mânuk is a very interesting survival of a New England loanword, *i. e.*, from Nat. *monak* "an English coat, a petticoat"; cf. RW. *maunek* "a European garment" (see *Natick Dict.*, p. 266).

Nîskâhíkĭán must stand for *mĭskâhíkĭán* "cider" which is a derivative from Del. *masgichlen* "May apple" (*Len. Dict.*, p. 74, 19).

N'pûmĭâs is translated by Harris "barn," but is clearly a form of Del. *nibahwi*, *i. e.*=*n'pûwiâs* "during the night"; cf. the Del. *nibahwi* and Aben. *nibôiwi* "in the night-time."

Nŭnŭ'pâ "lift up" must be a reduplicated form of Del. *nipachton* "raise up." I think the guttural breathing should have been on the third syllable, *i. e.*, *nŭnŭpâ'*.

Rŭ́tĭg "crushed corn"; Peq. *yŏ́kĕg*; Nat. *nuhkik*, lit. "some-

terminate vowel similar to a short ĕ. The consonants have the same values as in English, except š=*sh* and ', which is a soft rough breathing like the Arabic medial *h*. In the Abenaki the ô is a nasal as in French *on* in *mon*. The Natick and Narragansett words are quoted in the English system which was followed by Eliot and Roger Williams, while the Delaware material is given in the German notation, following the usage of Brinton's Lenâpe Dictionary.

thing softened," according to Eliot, "flour." This word appears as *rucat* in the old New Jersey Lenâpe trading idiom. Cf. Aben. *nokhigan* "flour"; Del. *loken*, from the stem *lokenummen* "smash up, crush." Note that *r*, *y* and *n* interchange in the N. E. Algic dialects; cf. Nat. *nût*, Quiripi *rût* and Peq. *yût* (Stiles *yewt*) "fire" (see *s. v. škûkăríš*).

Šâmût "tripe" is evidently the same stem as Del. *schameu* "greasy," *Len. Dict.*, p. 126, 9.

Škûkăríš "snake" is a curious formation. It must of course be from *škûk* "snake"; Aben. *skog*; Nat. *askûk*; RW. *askug*; Morton N. E. Canaan *ascowke*; Peq. *skoogs* (with diminutive *-s*); Del. *achguk*. The *-rîš* ending is difficult. It probably stands for *-niš*, *i. e. škûkăníš* "a little snake," as distinct from "a serpent," with intercalated *n*. For interchange of *n* and *r* see *s. v. rûtĭg*.

Špûti, given by Harris as "buttocks," really means "anus." This is the same word as Del. *saputti* (Zeisberger), *Len. Dict.*, p. 124, 16.

Skwâ "woman"; Nat. *squaas*; RW. *squaw*; Del. *ochqueu*, *okhqueh*; the original stem meant "prepuce." This is a well-known Eastern word, but appears only as an ending in Abenaki, as in *kinjames-iskwa* "queen," from *kinjamés* "king" (=King James).

Sû seems to me to be a particle in the possible combination *k'sûkâgitĭnŏn* "we (incl.) shall drink." It may have a cohortative force.

Sûkkŭtăš "succotash" is a well-known N. E. word. Cf. RW. *m'sickquatash* "something beaten up," from *m'sukquttahhash* "the things (inan. pl.) beaten to pieces." *Sukquttahham* "he beats it to pieces." *Sûkkŭtăš* is plainly a loanword in the Skaghticoke dialect.

Tăpâsŭk, given by Harris as "hotel," probably stands for *nitâpêsŭk* "my friends" (dim. *-s*). Cf. Aben. *nidôba*, Penobscot *nidâbe*, Pass. *nîtăp* "my friend."

Tîpî "devil" is probably a Pequot loanword from Peq. *dibî* "devil," cf. Prince and Speck, *Anthrop.*, V, 203. The Del. word for "spirit" is *tschipey*, cf. Aben. *chibai*. *Tîpî* in Skaghticoke may, however, stand for Del. *tschipi* "strange," the same stem as *tschipey* "spirit."

Tûlĭpâs "turtle" is evidently a diminutive (*-s*) from *tûlĭpâ*;

cf. Del. *tulpe*, Aben. *tolba* "turtle"; Nat. *tunuppasog* "tortoises."

Wânŭx "white man," cognitive with Aben. *awanoch*, now used for "Canadian Frenchman"; Pas. *wenoch* "white man." Cf. Peq. Stiles *waunuxuk* "white men"; Nat. *awaunagessuck*, *Natick Dict.*, p. 253. The word is a derivative from the indefinite pronoun seen in Del. *auwen*, Aben. *awani*, Penobscot *aweni*, Munsee *awaun*, Pass. *wĕn*, "who, someone."

Wĭchŏwân "come along" and not "hurry up," as Harris gives it. Cf. Del. *witschewan*, Aben. *wijowi* "come along with me," etc. See *s.v. tăpăsŭk* and *kâgĭtĭnŏn*.

J. Dyneley Prince.

Stated Meeting, November 20, 1903.

President Smith in the Chair.

The following papers were read:

"The Testimony of the Huacos (Mummy-grave) Potteries of Old Peru," by Albert S. Ashmead. (See page 378.)

"On a Geological Tour to Labrador," by Prof. Amos P. Brown.

Stated Meeting, December 4, 1903.

President Smith in the Chair.

The decease of the following members was announced:

Dr. Charles Schäffer, at Philadelphia, on November 23, æt. 66 years.

Prof. Alphonse François Rénard, at Brussels, on July 9, æt. 61 years.

Mr. Henry Carey Baird made some remarks on "The Alaska Frontier."

Prof. Percival Lowell read a paper on "The Cartouches of Mars," which was discussed by Prof. Haupt, Prof. Conklin, Mr. Goodwin, Prof. Doolittle, Prof. Ernest W. Brown and Prof. Heilprin.

THE CARTOUCHES OF MARS.

BY PERCIVAL LOWELL.

(*Read December 4, 1903.*)

That changes take place upon the surface of Mars is manifest to anyone who has given the planet prolonged study. Not only do the polar caps wax and wane with regular rhythm, but the dark markings with which the disk is diversified deepen in tone or fade away as the months succeed each other. The phenomena known as the "canals" are likewise subject to transformation. At times they are conspicuous; at times invisible. And what is yet more striking, each canal has its own times and seasons, its exits and its entrances. What dates the one does not date its neighbor; and still less its antipodes. The Ganges will be seen when the Titan is invisible and the Titan be evident when the Ganges can scarcely be made out.

Particular "canals" are not sole instances of such change. On occasion "canals" in whole regions appear to be blotted out. The most careful scrutiny fails to detect them, though distance be at its minimum and definition at its best. Yet before or after, under conditions much less favorable, the region stands out peopled with lines. Even the strongest and best known of these strange pencilings seem at certain seasons but wan ghosts of their usual selves. As for their more tenuous companions, it almost taxes faith to believe that they can ever have existed at all.

In order to discover what, if any, law underlay these shifting phenomena, I bethought me some two years ago of deducing from my drawings the percentage of visibility of given markings at intervals during an opposition, and of then collating the results. The great number of drawings at my disposal at once suggested this method and increased its trustworthiness, since the accuracy of a percentage heightens with the number that go to make it up.

To get the percentage I had recourse to the following plan. Taking the mean longitude of the marking from the map, I considered all the drawings which, from the longitude of their centres, might be expected to show the marking within certain zones from the central meridian, and then noted the appearance or non-appearance in each of the marking in question. Three such

zones I thought it best to take—those from the centre to 20° out on either side of it; next, those from 20° to 40° out; and last those from 40° to 60° away. This tripartite arrangement had the advantage, which indeed was the reason of its adoption, of furnishing comparison between a marking's visibility at different distances from the centre of the disk. And I may say in passing—for the subject will occupy another paper—that these relative visibilities came out in accordance with what realities on the planet's surface would show.

Were the disk always full the application would be simple and forthright. Being presented generally with a phase, certain corrections have first to be introduced. Since the illumination degrades from the point under the sun out to the terminator where it ceases altogether, a marking from this cause alone tends to disappear as it nears that boundary, and indeed within a certain distance of the night-line can never be seen at all. As such *terra non* I took empirically a zone 25° in from the terminator, such being from my observations the mean value of the semi-obliterated area. Subsequent calculation shows that this is about the value needed to equalize the chances of detection in the three pair of zones mentioned above when all the factors of position conducing to visibility are taken into account.

Convenient epochs for testing the visibility of a canal were self-offered by its several presentations. A presentation of any part of the planet is the occasion of the presentment of that part to an observer upon the earth. As Mars takes forty minutes longer to rotate than our own globe, its longitudes lose on the average 9°.6 a day in coming to the disk's meridian. In consequence of thus slowly falling behind time they complete an apparent backward revolution in about 38 days (from 37 to 41 days), since 9°.6 goes into 360° some thirty-eight times. After the lapse of this period, the two planets again show the same face to each other at the same hour. For a third of the time, therefore, the marking is well placed for observation; for the other two-thirds, it is either not to be seen because the planet is below the horizon or practically invisible because the planet is not high enough up. Thus the presentations make natural epochs for comparing a marking with itself and noting any change in aspect it may have undergone in the interval.

The data were furnished by the drawings. In the present inquiry these consisted of those made by me at the opposition of 1903

just passed, 375 complete ones in all. They date from January 21 to July 26, inclusive, and were divided by months as follows:

January	18	
February	48	
March	49	
April	70	+ 1 unfinished.
May	63	
June	70	
July	57	+ 1 unfinished.
	375	+ 2 unfinished.

Sketches of particular parts are not included in the list, as being unfit for comparison purposes.

The principle I adopted in making the drawings was that of momentary representation. My object in each was not so much an exhaustive map as an instantaneous photograph. From ten to twenty minutes only was the time allotted to each. In that period the shift of the longitudes is not enough substantially to change the degree of visibility of a marking and thus to make of the drawing a composite picture.

Eighty-five canals were examined for presence or absence in these drawings. The average number of times a canal might have been seen, had it been sufficiently conspicuous, proved to be about one hundred. The number of times it actually was seen varied with the particular canal, some canals being but rarely detected, others being almost continuously visible. From the above it follows that eight thousand five hundred separate examinations for the visibility or non-visibility of the canals had to be made in all; an undertaking of some length, but adding proportionately to the trustworthiness of the result.

For getting the percentage visibility of a canal at any presentation it seemed on the whole best to consider all three of the above pair of zones together, or, in other words, the percentage of visibility within 60° of the central meridian, limited as above described toward the terminator. Any other pair of zones might have been used with equal correctness, but the greater number of determinations got from considering all three together commended itself for its increased accuracy.

The percentages thus obtained proved sufficiently suggestive, even before any corrections had been applied. To give them,

however, their full import two corrections had in rigor to be taken into account: one for the varying distance of the planet and the other for the varying quality of the seeing. At the several presentations the planet was not at the same distance from the Earth. Now distance affects the visibility of a marking by altering its size. If the markings be large, their apparent size decreases as the square of the distance. If, as in the case with the "canals," they have length without width, we may take them as of one dimension. For beyond a certain length increase of that quantity does not seriously affect the visibility. Their width, however, although unrecognizable as such, improves their chance of being seen in the direct ratio of the planet's approach.

Now if we take the chance that a canal of twice the width of a given one is twice as likely to be made out, we may regard it as the inverse of the relative chance of commission of twice a given error of observation. We may then use the areas bounded by the curve of probability, with the width of the canals taken for abscissæ, respectively as the measures of the likelihood of detection in the two cases, since these areas include all the chances of seeing a canal of the given width. By taking the area from the central ordinate of the curve out to where that area shall equal the percentage of visibility shown at a given distance, then multiplying the ordinate there found by the inverse ratio of the given distance of the planet at the time to some fixed distance taken as standard, and then finding the area corresponding to this last ordinate, we shall get the percentage at the standard distance. It will be noted that on this principle, as the planet approaches the Earth the percentage of visibility increases gradually to unity, that is certainty of detection if the object exist at the time, since the area enclosed by the curve of probability approaches unity as the abscissa is indefinitely increased. For standard distance I took that of the planet's nearest approach to us during the opposition, when its disk subtended 14″.6 of arc. On this principle have been computed the corrections for distance.

The correction for the seeing was got in the following way. The seeing at the time of each drawing was entered in the course of observation by the side of the drawing, together with all the other marginal notes. By taking the mean of these values for all the drawings which entered into the determination of the percentage visibility of a given canal at a given presentation, we get the mean seeing under which it was observed. The correction needed in

consequence was then applied to the curves of visibility as now to be described.

Using the percentages of visibility as ordinates and the times before and after the summer solstice of the planet's northern hemisphere as abscissæ, I plotted the resulting determinations and connected the points so found by a smooth curve. These curves may be called the cartouches of the canals, since they are their distinctive sign-manuals. Each portrays on its face the varying visibility of its canal during the time that it was under observation, but it masks much more. Were the canal intrinsically unchangeable, its curve or cartouche would be a straight line, since corrections for all extrinsic causes of apparent variability have already been applied. Its cartouche would be a line parallel to the axis of abscissæ and at a distance from it proportionate to the canal's strength. On the other hand, any intrinsic change in the canal reveals itself at once by a departure from a straight line. If the canal be for any reason augmenting, its curve will rise; if it be dwindling, the curve must fall. Thus the curves or cartouches tell us not only of the apparent change in visibility but of the real change in development during examination.

On scrutinizing the cartouches the first point noticeable is the well-nigh total absence of straight lines among them. There are but two or three instances throughout the eighty-five. Thus the great majority of the canals were, during the time they were under observation, in a state of flux. For the quiescence of the remaining few we shall a little later in the paper be able to assign a probable cause.

It is next to be noticed that opposition fell not far from the centre longitudinally of the curves, and the time of the planet's nearest approach to the Earth still nearer the middle, since the first of these events happened on the 30th of March, the second on the 3d of April. The summer solstice occurred earlier, on February 28. Another epoch worthy of regard is the date of the first frost in the Arctic regions. This, as explained elsewhere (*Lowell Observatory Bulletin*, No. 1), took place 126 days after the northern summer solstice. It is indicated in the first diagram by a dotted line.

On casting one's eye down the list of cartouches arranged alphabetically, no order or law is apparent. Some canals had their minimum early, some late, according seemingly to their own personal peculiarity. But if now we seek some natural order and

take the latitude as a probable criterion, we shall suddenly be aware of a very different state of things. As the canals are not points but lines, we must select for purposes of precision some point in them as their distinctive latitude and longitude. Their mean point, or more properly the mean of all their points, has therefore been taken in each case, since it is with mean values that we find ourselves concerned. On this principle we may classify the canals by zones of latitude, advancing down the disk from the north polar cap. The canals were therefore ticketed and arranged according to the following zones:

Arctic zone, containing the canals whose mean latitude lay between					86°N.–65°N.
Sub-Arctic zone,	"	"	"	"	65°N.–50°N.
North Temperate zone,	"	"	"	"	50°N.–35°N.
North Sub-Tropic zone,	"	"	"	"	35°N.–25°N.
North Tropic zone,	"	"	"	"	25°N.–10°N.
North Equatorial zone,	"	"	"	"	10°N.–0°
South Equatorial zone,	"	"	"	"	0° –10°S.
South Tropic zone,	"	"	"	"	10°S.–25°S.
South Sub-Tropic zone,	"	"	"	"	25°S.–35°S.

86°N. was taken as starting-point because of the coming down of the north polar cap to about this latitude throughout the course of the observations. On the other hand the lowest zone extends only to 35°S., because, owing to the tilt of the north pole of the planet toward the earth, a tilt which ranged between 21°.1 and 25°.9 during the same period, the farthest observable canal south had 27°S. for its mid-point. The date at which each canal was at its minimum visibility is shown in the following list:

TIME OF MINIMUM DEVELOPMENT OF CANALS.

Arctic Canals—86°–65° Lat. North.

Lat. N.	Name.	No. of Canals.	Days After Summer Solstice.		
78°	Ceraunius N.....		4		
75°	Sirenius N.....		6		
74°	W. Kison.....		0		
72°	E. Kison.....		0		
71°	Jaxartes.....			—3	
69°	Rhizius.....			—9	
65°	Hades.....		2		
		—	—		
		7	0	Mean	0

Sub-Arctic Canals—65°–50° Lat. North.

Lat. N.	Name.	No. of Canals.	Days After Summer Solstice.	
64°	Syrgis		11	
63°	Empetis		14	
62°	Pierius		18	
58°	Callirrhoe		10	
57°	Singames		15	
52°	Jomanes		12	
		6	80	Mean 13

North Temperate Canals—50°–35° Lat. North.

49°	Arnon		7	
49°	Dis N		24	
47°	Ceraunius S		24	
42°	Halex		25	
42°	Styx		28	
42°	Udon		20	
36°	Sirenius Middle		25	
		7	153	Mean 22

North Sub-Tropic Canals—35°–25° Lat. North.

35°	Gihon II		59*	
34°	Isiacum		53*	
33°	Brontes N		27	
33°	Titan N		30	
32°	Britannia		20	
32°	Nasamon		43	
30°	Sitacus N			−9*
28°	Dis S		29	
28°	Nilokeras		35	
28°	Phison N		42	
27°	Euphrates N		42	
		11	371	Mean 34
				Mean *33

North Tropic Canals—25°–10° Lat. North.

25°	Phrixus		42
25°	Pyriphlegethon N		34
23°	Djihoun		43
23°	Jamuna N		47
23°	Libycum		54

* Denotes a canal *extra ordinem*, which is omitted in the starred mean.

Lat. N.	Name.	No. of Canals.	Days After Summer Solstice.	
22°	Acheron		35	
22°	Indus		64*	
22°	Nilokeras II		42	
21°	Lethes		44	
21°	Thoth		25*	
20°	Hiddekel		55	
20°	Tamyras N			
19°	Oxus		42	
19°	Uranius		28	
18°	Is		40	
17°	Erebus		31	
16°	Gihon I		50	
16°	Sitacus S			—14*
15°	Amenthes		67*	
15°	Apis		18*	
12°	Adamas		46	
11°	Hydaspes		45	
		22	838	Mean 40
				Mean *42

North Equatorial Canals—10°–0° Lat. North.

10°	Gigas N		46	
8°	Orcus		50	
7°	Phœnix		43	
6°	Cerberus N		49	
5°	Euphrates S		48	
5°	Phison S		47	
4°	Chryssorrhoas		42	
4°	Iris		47	
3°	Nepenthes		25*	
2°	Triton		26*	
0°	Fortunæ		46	
0°	Ganges		47	
		12	516	Mean 43
				Mean *47

South Equatorial Canals—0°–10° Lat. South.

Lat. S.	Name.	No. of Canals.	Days After Summer Solstice.
0°	Brontes S		50
1°	Clitumnus		52
2°	Pyriphlegethon S		54

Lat. S.	Name.	No. of Canals.	Days After Summer Solstice.	
2°	Titan S.		60	
4°	Jamuna S.		53	
5°	Cerberus S.		54	
5°	Tartarus		63	
5°	Ulysses		71	
6°	Læstrygon		52	
7°	Cyclops		46	
8°	Orosines		58	
10°	Ausonium		66	
10°	Dosaron		56	
		13	735	Mean 57

South Tropic Canals—10°–25° Lat. South.

12°	Erymanthus		54	
12°	Gigas S.		54	
12°	Sirenius S.		63	
15°	Tithonius		73	
17°	Dargamanes		76	
17°	Elison		68	
18°	Aurum		73	
25°	Deucalion		80	
		8	541	Mean 68

South Sub-Tropic Canals—25°–35° Lat. South.

27°	Nectar	1	95	Mean 95

Of the eighty-five canals the number falling into each zone respectively was as follows:

Arctic zone	7	Canals.
Sub-Arctic zone	6	"
North Temperate zone	7	"
North Sub-Tropic zone	10	"
North Tropic zone	22	"
North Equatorial zone	12	"
South Equatorial zone	13	"
South Tropic zone	7	"
South Sub-Tropic zone	1	"
	85	

Naturally the canals on a globe are more numerous near the equa-

tor. Why the north tropic ones are more numerous than the south tropic in the list we shall see later.

Taking now the position in time of the minimum value of the curve of each canal within a given zone, and then determining the mean minimum for all the canals in that zone, we find as follows:

	Mean Minimum, in days after the Summer Solstice.	Or Exclusive of Starred Canals.
Arctic zone	0	0*
Sub Arctic zone	13	13*
North Temperate zone	22	22*
North Tropic zone	34	33*
North Sub-Tropic zone	40	42*
North Equatorial zone	43	47*
South Equatorial zone	56	56*
South Tropic zone	68	68*
South Sub-Tropic zone	95	95*

Disclosed stands a steady progression in the time of minimum development of the canals as we travel from the neighborhood of the polar cap to the equator. The orderly advance becomes even more noticeable when certain canals which appear to contain mistakes or misidentifications or mutual exchanges of visibility are eliminated. Such seem to be the Amenthes-Thoth-Nepenthes-Triton system, in which just after opposition the Thoth-Nepenthes-Triton apparently replaced the Amenthes, and then died down later as if nothing out of order had happened. The Indus and the Gihon II, or that part of the Gihon north of the Deuteronilus, are not impossibly another case of interchange. The two Sitacus and the Apis may be cases of straight li[illegible]* masked in their earlier presentations by distance and unfavorable seeing. For the out-of-place development of the Isiacum, I am at a loss satisfactorily to account. Omitting the above canals from the count we get the second row of minima, which show a yet closer approach to uniformity of progression. Indeed, if we now plot the mean curves or cartouches of the mean canals at ordinal intervals corresponding to the degrees of latitude at which they occur, we shall find that a straight line will nearly pass through all the points. This is shown in Plate XV, which, based on Mercator's projection, makes of the straight line a curve slightly convex on the advancing side. But what is more remarkable, the progression does not stop at the

equator, but continues on into the planet's southern hemisphere, the sign curvature changing when it crosses the line.

Thus much of canal development the curves definitely state; but we may infer more.

Whatever constitute the canals, it is evident that their development proceeds from the pole down the disk, and, furthermore, that it advances over the surface at a fairly regular rate. It starts at the summer solstice; that is it follows the melting of the polar cap. This suggests the source of the quickening. In consequence of the water then let loose the "canals" come into being. That this can be due to a bodily transference of matter, the water in question, seems negatived by the area concerned. More darkened area is gained than is lost. But this is not an easy point to be sure of. More forthright is the negativing of such transference by the time taken. Water would make its presence felt long before the actual darkening takes place. For at the latitude of 75°, the mid-latitude of the Arctic canals, the darkening begins on the day of the summer solstice, which is considerably after the date of the most rapid melting of the cap.

But though water directly does not account for the phenomenon, water indirectly does. A quickening to growth of some kind would produce the counterpart of what we see. And these statistics furnish us with a key to its character. It is a seasonal change, but a little consideration will suffice to show us that it is quite unlike in behavior the seasonal change we know on earth.

Could we get off our earth and view it from the standpoint of space we should mark, with the advent of spring, a wave of verdure sweep over its face. If absence of cloud permitted of an unveiled view this flush of waking from its winter's sleep would be evident, and could be watched and followed as it crept higher and higher up the parallels. Starting from the equator shortly after the sun turned north, it too would travel northward toward the pole. Here, then, we should mark, much as we mark it on Mars, a wave of darkening, the blue-green of vegetation superposed upon the ochre of ground, spreading over the planet's surface; but the two would differ, the mundane and the Martian vegetal awakening, in one fundamental respect—the earthly wave travels from equator to pole; the Arean from pole to equator. Clearly the causes compelling them differ. Yet are they both seasonal in character. To what then is the difference due? To the presence or absence of moisture.

Two things are necessary to the begetting of vegetal life, the raw material and the reacting agent. Oxygen, nitrogen, water and a few salts make up the first, the sun does the second. Unless both be present the quickening into life never comes. Now the one may be there and the other not, or the other there and the one not. On earth the material including water is, except in certain destitute spots, always present; the sun it is that periodically withdraws. Observant upon the coming of the sun is then the annual quickening of vegetal life. On Mars, on the other hand, it is the water that is lacking. This we know from many other phenomena the disk presents. There is no surface water there save for what comes from the periodic thawing of the polar caps. Vegetation cannot start in any quantity until this water reaches it. Vegetal change, therefore, on Mars should start from the pole and travel equatorward. On the earth it should do the precise opposite. Now such is exactly what the curves of visibility of the canals exhibit. Timed primarily not to the coming of the sun but to the coming of the water, vegetal life there follows not the former up the latitudes but the latter down the disk. We may conclude then that the canals are strips of vegetation fed by water released from the polar cap.

The two curves of phenological quickening, the mundane and the Martian, are shown in Plates XVI and XVII. The stars mark the dead-points at successive latitudes.

We now come to a deduction from the evidence before us even more startlingly pregnant of information. Glancing at Plate XV of the mean canals, we see that the quickening proceeds rapidly and very nearly if not quite uniformly down the disk. It takes the darkening only fifty days to descend from the seventy-first parallel to the equator, a journey of some 2600 miles. This means a speed of fifty-three miles a day, or two and two-tenths miles an hour. And it does this in the face of gravity. For the spheroidal flattening of Mars, $\frac{1}{190}$ of the polar diameter, shows that the figure of the planet is in fluid equilibrium under the axial rotation. A particle of water, therefore, would know no inclination to move from where it initially was. Of its own accord it would not flow toward the equator. And as it does flow toward the equator, and with a remarkably steady progression too, the inference seems inevitable that it must be carried thither by artificial means. We are thus led to an artificial origin and maintenance of the markings called canals, and one which in essence justifies that appellative. Nor do I see any escape from the deduction.

This idea is strengthened by another circumstance connected with the development exhibited by the table. The progress of the minima, which betoken the later and later starting of the quickening down the disk, does not stop at the equator, but advances with fine indifference to that natural limit into the planet's other hemisphere. Now there the physical conditions to affect it are the precise opposite of what they were in the first or northern one. If, therefore, it were due to such cause the action should there be reversed. That it is not shows that we are here face to face with a phenomenon not simply inexplicable on natural laws but absolutely antagonistic to them.

The study here presented leads, then, to three conclusions: (1) The "canals" develop down the disk from material supplied by the melting of the polar cap; the development proceeding across the equator into the planet's other hemisphere. (2) The canals are from their behavior inferably vegetal and (3) of artificial origin.

BOSTON, December 4, 1903.

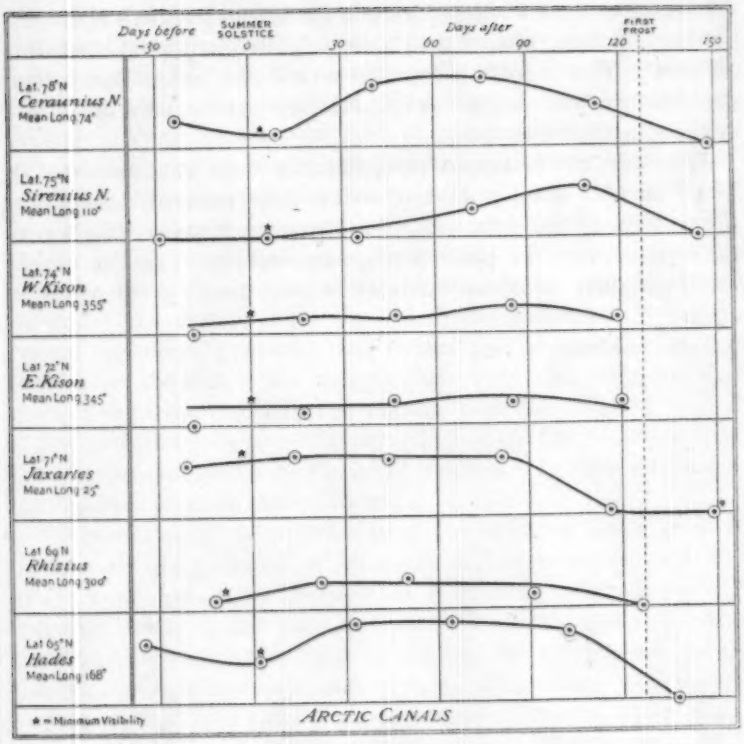

Days before
SUMMER SOLSTICE
Days after
FIRST FROST
-30
0
30
60
90
120
150
Lat. 78°N
Cerauntus N
Mean Long 74°
Lat. 75°N
Sirenius N.
Mean Long 110°
Lat. 74°N
W. Kison
Mean Long 355°
Lat. 72°N
E. Kison
Mean Long 345°
Lat. 71°N
Jaxartes
Mean Long 25°
Lat. 69°N
Rhizius
Mean Long 300°
Lat. 65°N
Hades
Mean Long 168°
* = Minimum Visibility
ARCTIC CANALS

Plate I.

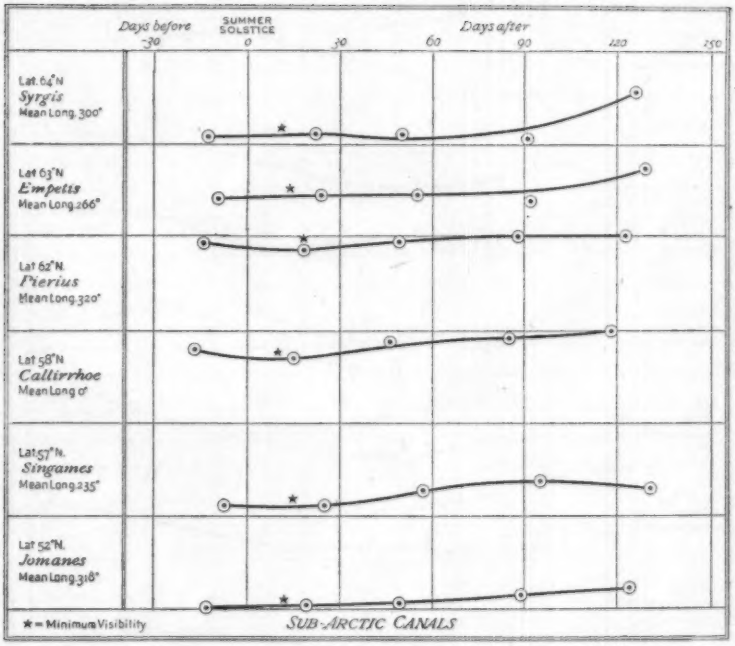

Days before
SUMMER SOLSTICE
Days after
-30
0
30
60
90
120
150
Lat. 64°N.
Syrgis
Mean Long. 300°
Lat 63°N.
Empetis
Mean Long. 266°
Lat 62°N.
Pierius
Mean Long. 320°
Lat 58°N.
Callirrhoe
Mean Long 0°
Lat 57°N.
Singames
Mean Long. 235°
Lat 52°N.
Jomanes
Mean Long. 318°
★ = Minimum Visibility
SUB-ARCTIC CANALS

Plate II.

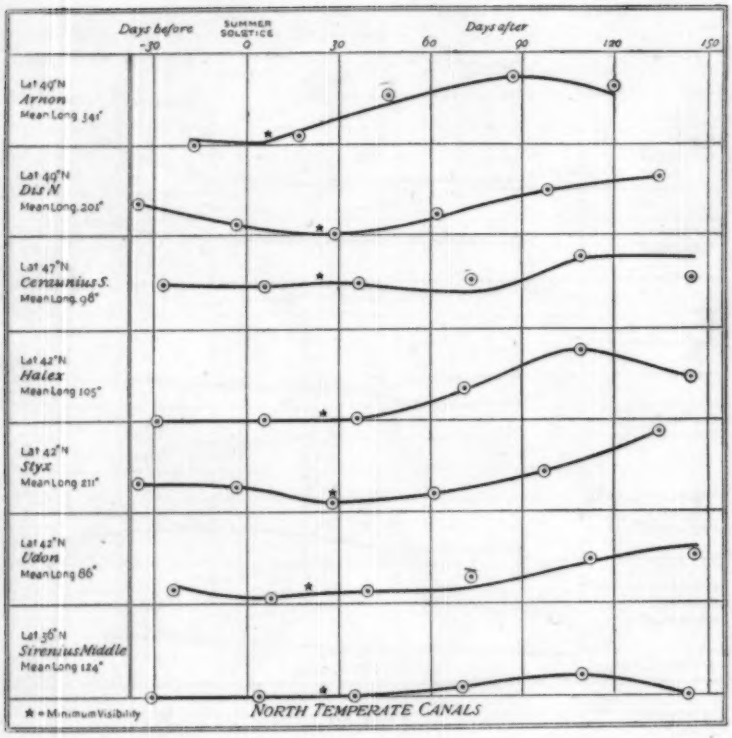

Days before
SUMMER SOLSTICE
Days after
-30
0
30
60
90
120
150
Lat 40°N
Arnon
Mean Long 341°
Lat 40°N
Dis N
Mean Long 201°
Lat 47°N
Cerberus S.
Mean Long 98°
Lat 42°N
Halex
Mean Long 105°
Lat 42°N
Styx
Mean Long 211°
Lat 42°N
Udon
Mean Long 86°
Lat 36°N
Sirenius Middle
Mean Long 124°
★ = Minimum Visibility
NORTH TEMPERATE CANALS

Plate III.

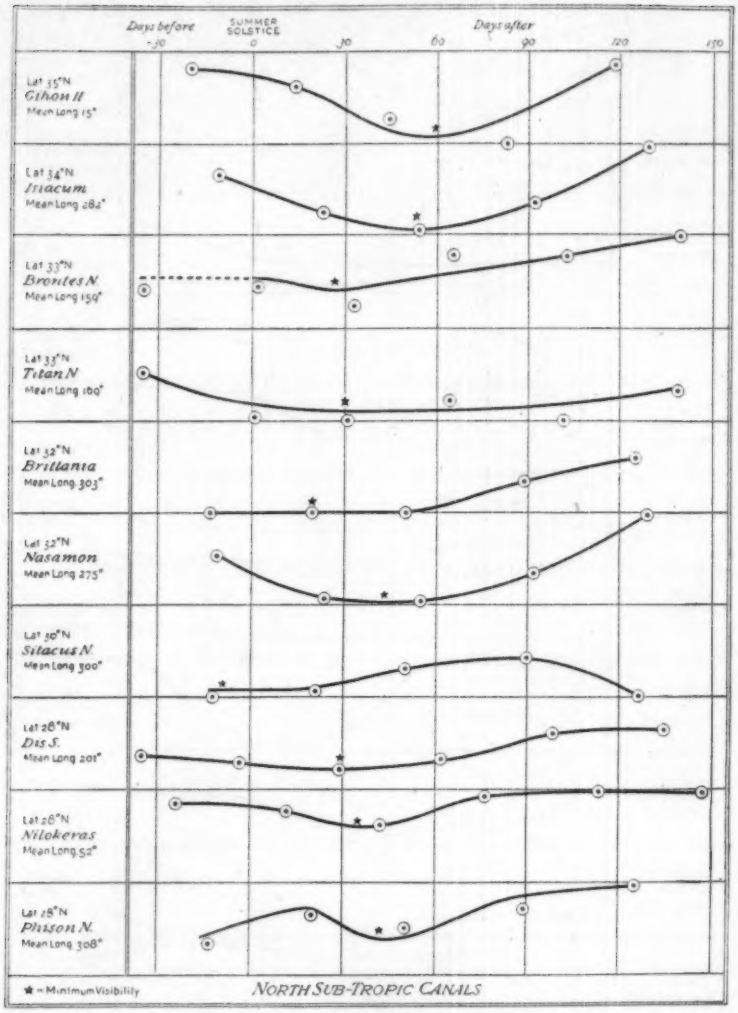
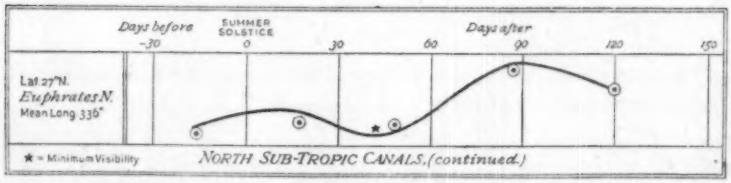


Plate IV.



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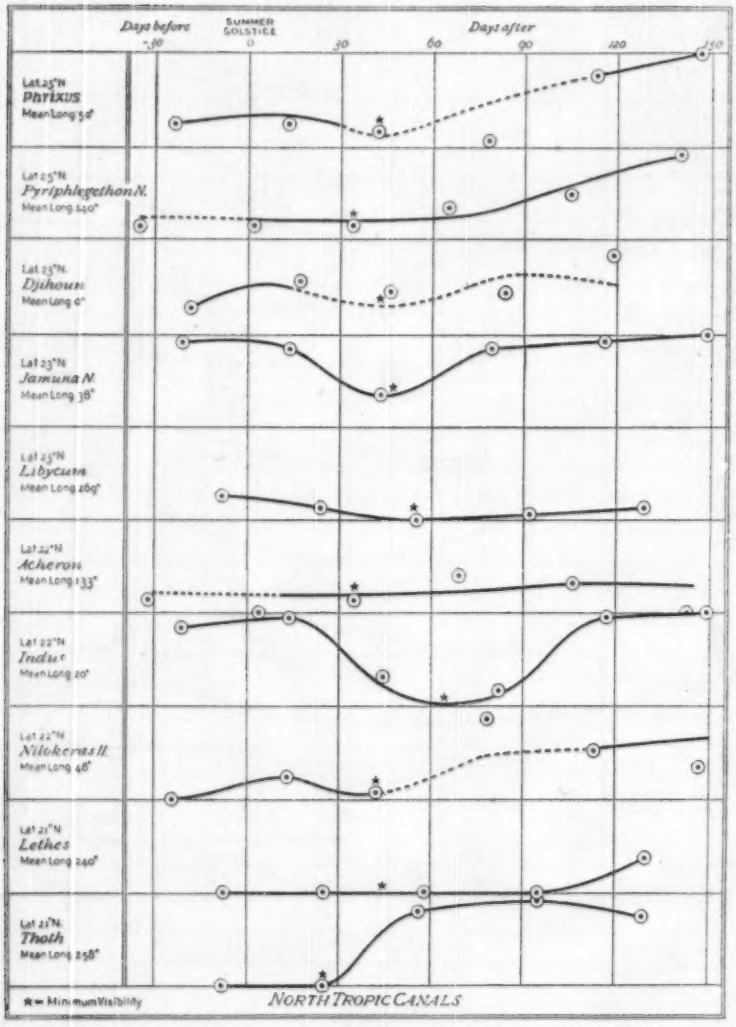


Plate VI.

The broken lines denote such portions of the curves as for certain intrinsic reasons seems the more probable.

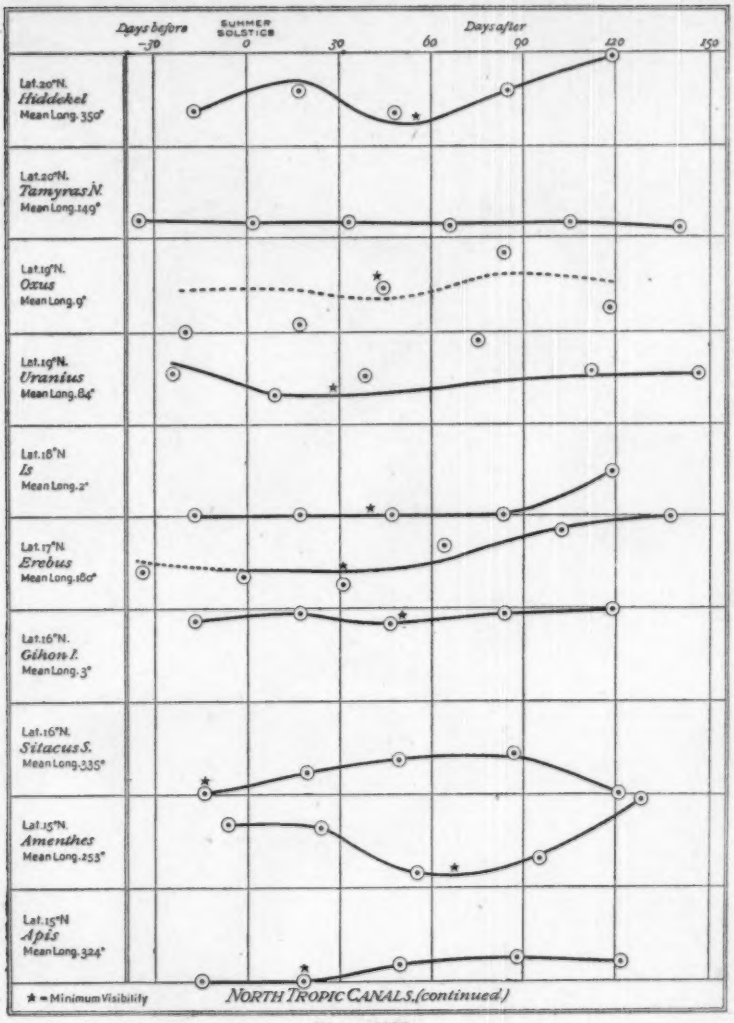


Plate VII.

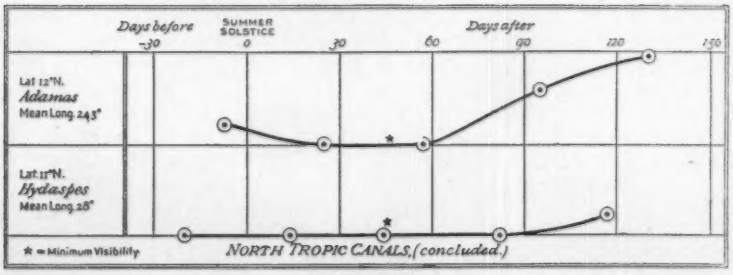


Plate VIII.

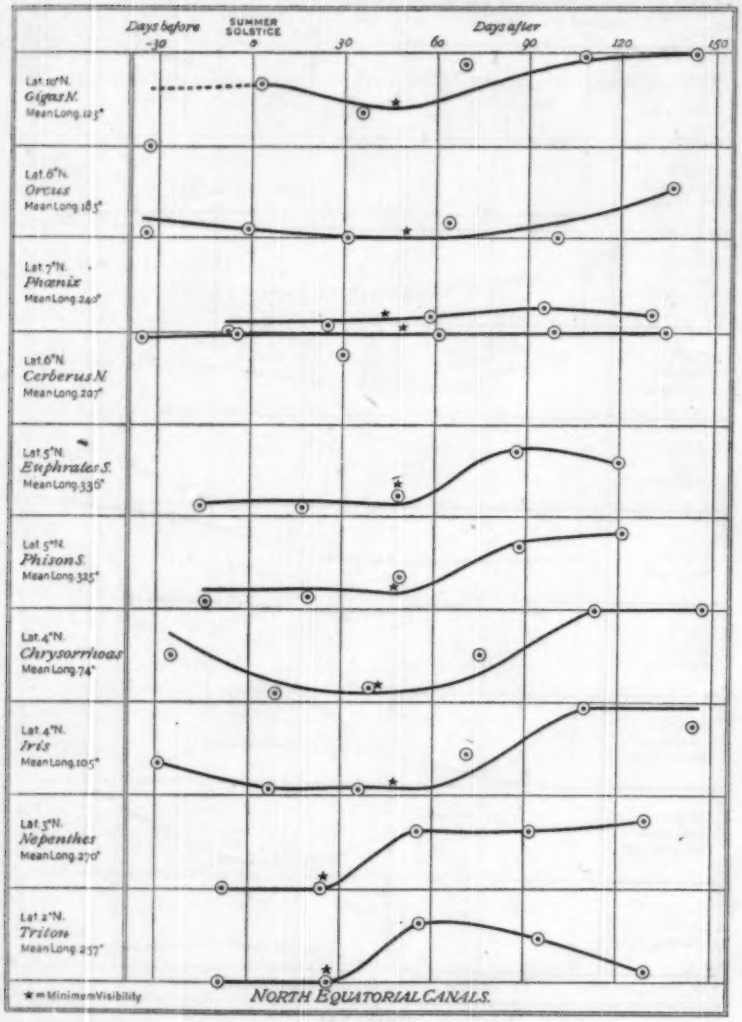


Plate IX.

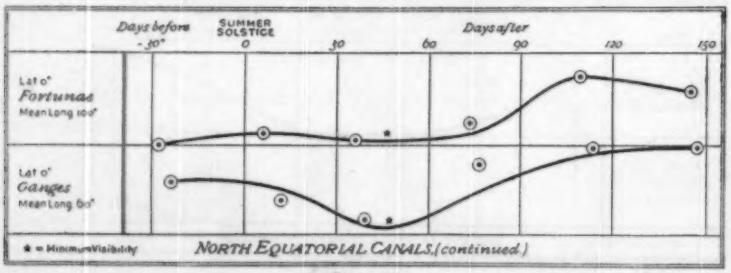


Plate X.

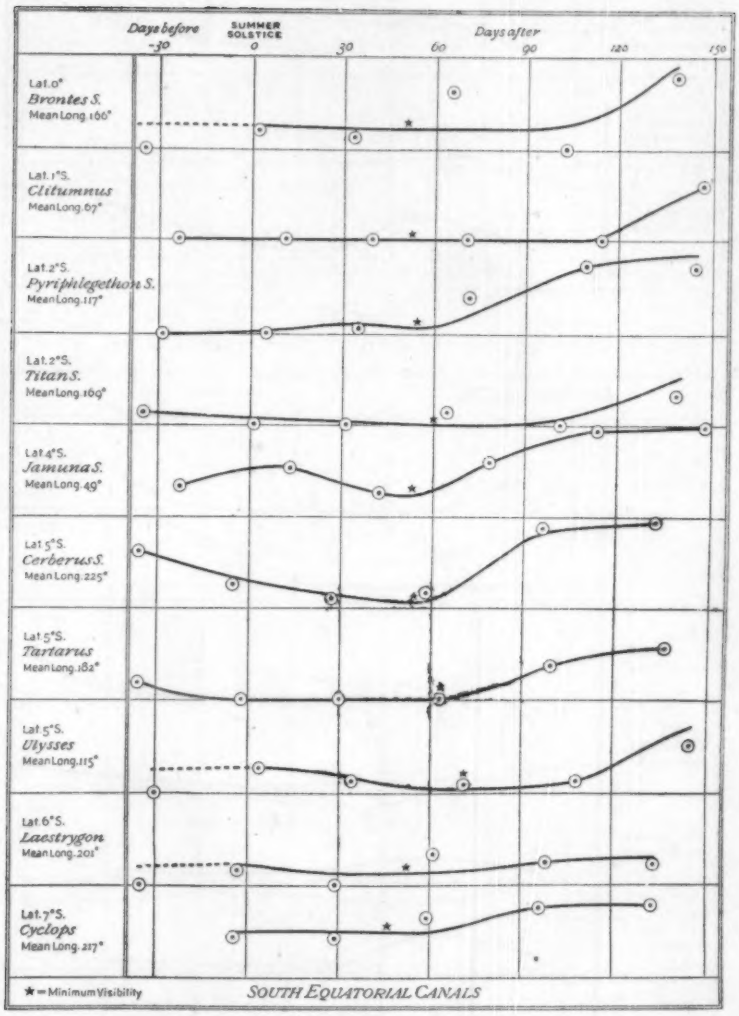

Days before
SUMMER SOLSTICE
Days after
-30
0
30
60
90
120
150
Lat. 0°
Brontes S.
Mean Long. 166°
Lat. 1°S.
Clitumnus
Mean Long. 67°
Lat. 2°S.
Pyriphlegethon S.
Mean Long. 117°
Lat. 2°S.
Titan S.
Mean Long. 169°
Lat. 4°S.
Jamuna S.
Mean Long. 49°
Lat. 5°S.
Cerberus S.
Mean Long. 225°
Lat. 5°S.
Tartarus
Mean Long. 182°
Lat. 5°S.
Ulysses
Mean Long. 115°
Lat. 6°S.
Laestrygon
Mean Long. 201°
Lat. 7°S.
Cyclops
Mean Long. 217°
★ = Minimum Visibility
SOUTH EQUATORIAL CANALS

Plate XI.

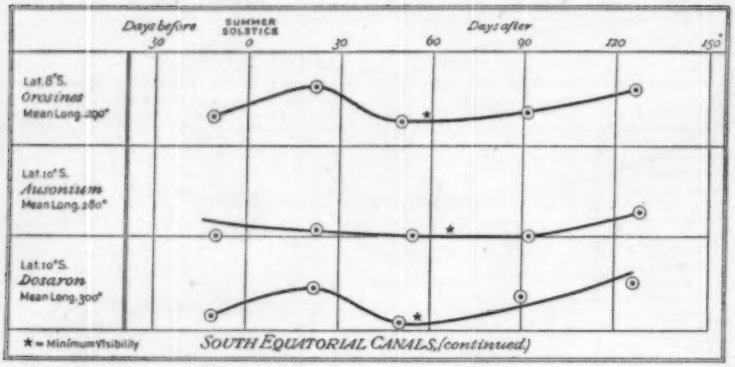
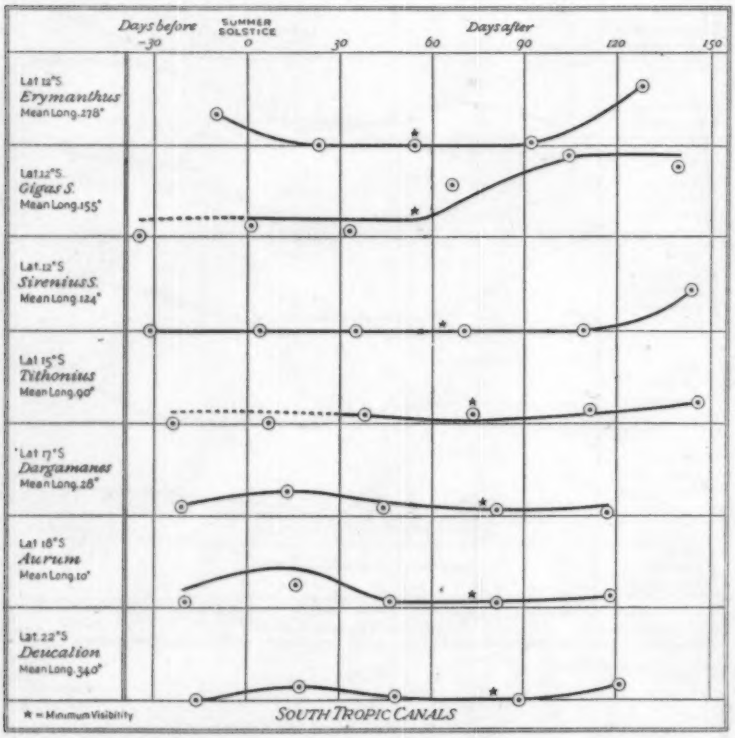


Plate XII.



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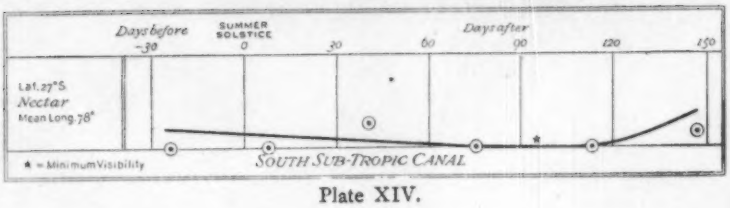

Plate XIV.

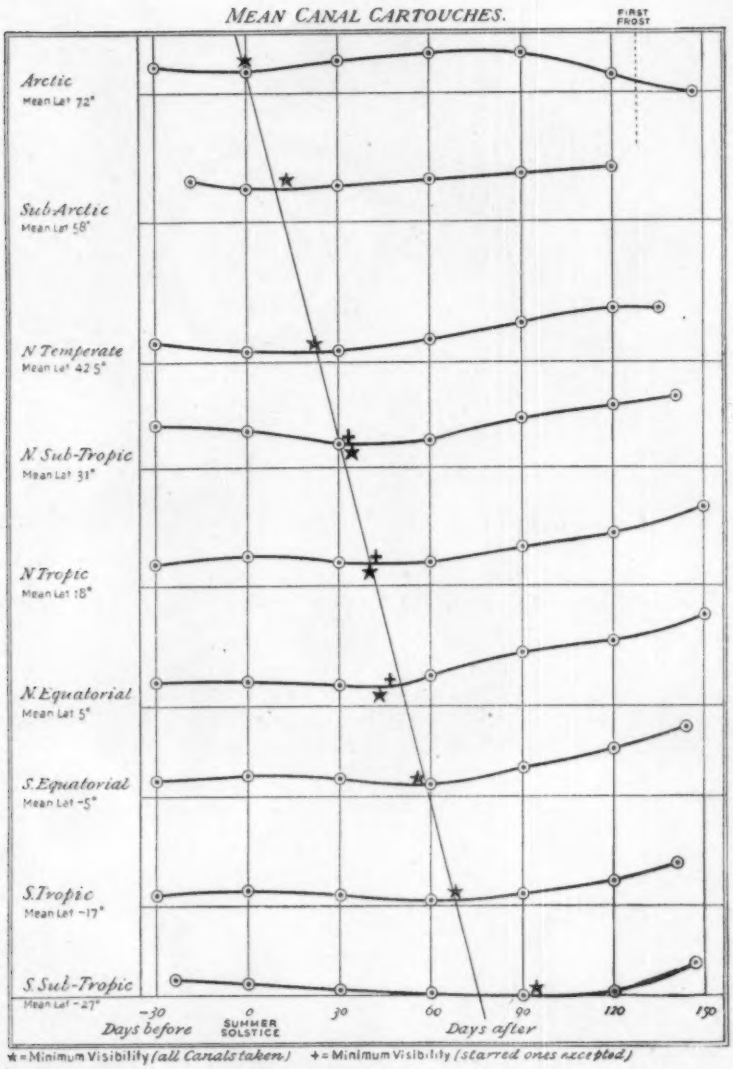

Plate XV.

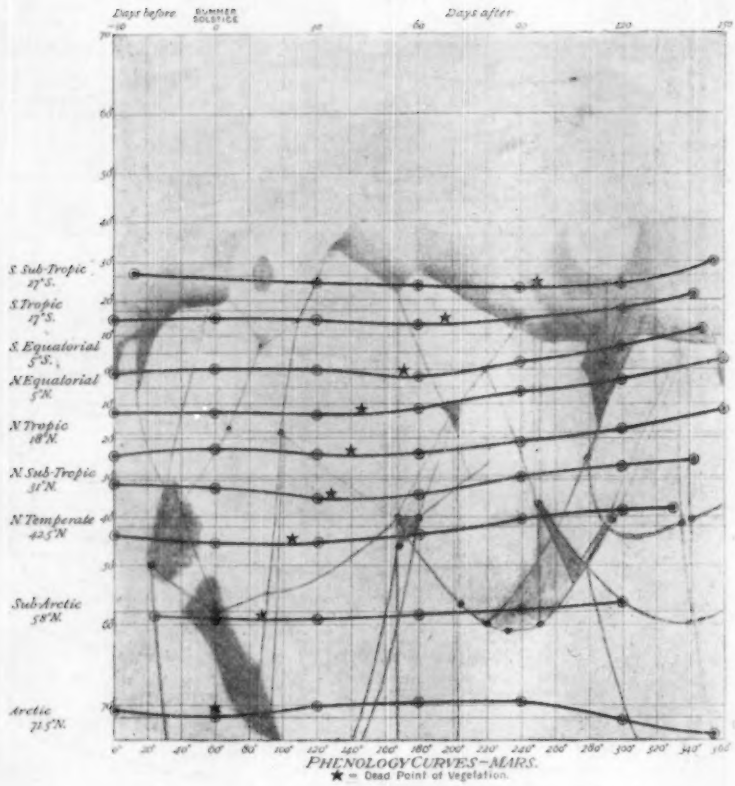
Days before
SUMMER SOLSTICE
Days after
S. Sub-Tropic 27°S.
S. Tropic 17°S.
S. Equatorial 5°S.
N. Equatorial 5°N.
N. Tropic 18°N.
N. Sub-Tropic 31°N.
N. Temperate 42.5°N.
Sub-Arctic 58°N.
Arctic 71.5°N.
PHENOLOGY CURVES—MARS.
★ = Dead Point of Vegetation.

Plate XVI.

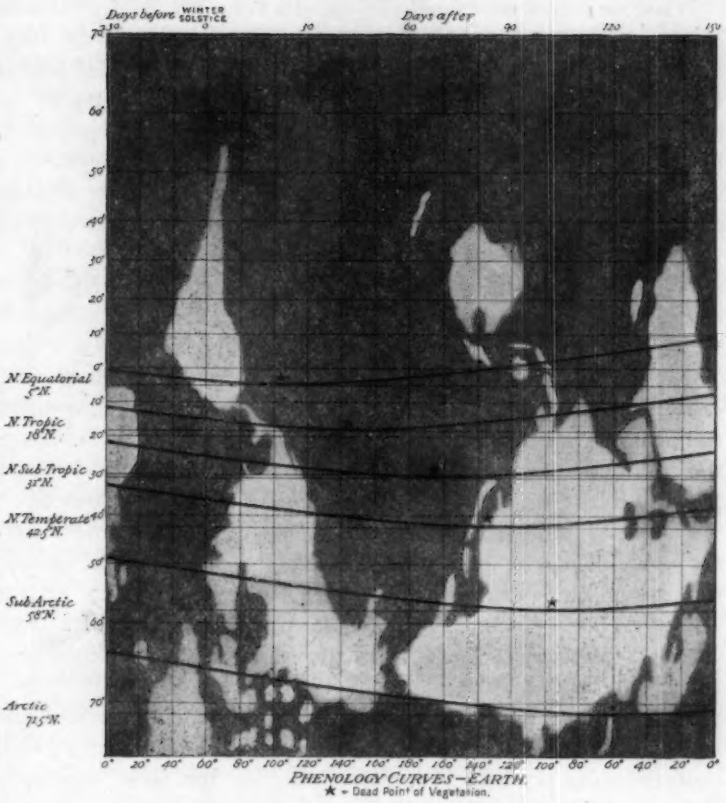
Days before WINTER SOLSTICE
Days after
N. Equatorial 5° N.
N. Tropic 16° N.
N. Sub-Tropic 31° N.
N. Temperate 42.5° N.
Sub Arctic 58° N.
Arctic 71.5° N.
PHENOLOGY CURVES—EARTH.
★ = Dead Point of Vegetation.

Plate XVII.

TESTIMONY OF THE HUACOS (MUMMY-GRAVE) POTTERIES OF OLD PERU.

BY ALBERT S. ASHMEAD, M.D.

(*Read November 20, 1903.*)

When we search the cemeteries of old Peru, we find by the side of every mummy a number of objects which are useful for him. His pious hands have within ready reach whatever is needed for his eternal voyage. Drink being indispensable in a country of so much dryness as Peru, good care was taken to place convenient to his hands a quantity of water or wine vessels to appease thirst.

These clay vessels have human form and give rise to our admiration, just as do the statuettes of the Egyptian tombs or the earthen *Cuites* found in those of Tanagras among the Greeks.

Historians agree in recognizing in these Egyptian and Grecian images the *double* or duplicate or soul which survives the departed. Death was definite only if these statuettes disappeared.

The belief in a soul, very widespread among every people, existed in Peru. And to satisfy it these people found it convenient to transform the drinking vessel into a *soul*, that is to say, an image resembling the deceased. Besides, these little potteries had reality pleasing to the artist. The varieties of them are great, representing the child, the woman, the old man, the fat, the lean, the noble and the poor man, with every expression of physiognomy, as sorrow, joy, anger, etc. Occasionally the figures have pendants on the ears or the nasal septum perforated for the introduction of a ring. This last character of figure is in the Museum of the Trocadero, Paris.

Some of these potteries show signs of diseases. I have seen one representing a double hare-lip. Syphilitic and lupoid (wolf-cancer) lesions are very frequently shown on the faces, especially the nose and upper lip. We know that these diseases existed in America long before the time of Columbus, and some eminent scientists have made the mistake to believe that because the former disease was very widespread, so common that the old Mexicans had deified it by incarnation into a god (Nanahuatl), that it was carried first to Europe by returning Spaniards. But this is a great mistake, for Virchow shows that this disease had existed in Europe certainly as early as 1472. And Raymond, of Paris, who dug up the bones of

the "Madeleines" of France, as the cemeteries of the old leper asylums of the middle ages are called, found unmistakable evidences of its presence as early as the eleventh, twelfth and thirteenth centuries. Evidently many persons afflicted with that destructive disease were thought to be lepers and were locked up to die with them. In ancient Mexico this disease was considered as that of the nobles, the great, a sort of "King's evil." The origin of it in America has been thought by the same scientists to be by a migration of those ancient races from Asia. This is also a great mistake. For had that disease come from Asia, leprosy would have come with it. Now there was no leprosy in those ancient races until Spaniards, Portuguese and negroes had inoculated them with the germs. Syphilis originally in America was the disease of the ancient llama, the pack-animal of Incans and Aymarans.

When the ice age had retreated northward and the rivers and valleys of South America became flooded, man emigrated in two ways, in latitude with his beloved and necessary reindeer northward with the snow, and in altitude with his beloved and necessary llama to escape the floods. This animal was a part of his household—his horse by day and his blanket by night, for its alpaca wool kept him warm on Andean heights. Thus man contracted the disease which belonged to the llama.

As to the origin of lupus (wolf-cancer), which is also represented frequently on the "huacos pots" of the mummy-graves, it came from the birds, especially parrots, of the Andes. Lupus is skin-consumption. Its germ is the bacillus of Koch. Insects would feed on the parrots dead of aviary tuberculosis and then inoculate human beings. Thus there would be local contamination, skin-tuberculosis, which quickly became systemic. As soon as the lungs of man became affected, his sputum acted as a means of propagating the disease in his family and village.

Amputation of the feet is also a common representation on these potteries and it is real, with flaps covering the ends of bones. But never is a hand shown as amputated.

Noses and upper lips are represented as clean cut off, evidently by a surgeon of skill, to cure wolf-cancer of those parts. This surgical procedure must have been quite commonly practiced in those pre-Columbian days.

In the guano beds of the Chincha Islands, as Mantegazza tells

us in his *L'Amour dans l'humanité*, there have been found some wooden figures bearing about the neck a serpent which was believed to devour the body. These images were *idols*, and this representation was the expression, as I defined it, of the disease, syphilis, before those ancients of Peru had a word for it in their language. The serpent is represented in the act of devouring a certain part of the body in a series of the figures preserved in the Museum of the Trocadero. There is also one of these figures in the American Museum in New York.

Here are five of these Peruvian vessels, presented to the Museum of Paris by Mr. Drouillon and derived from Moche. All show in diverse degree some destructive lesions of the upper lip and of the nose.

Figure 1. Peruvian Vase from Moche (Museum of the Trocadéro). The extremity of the nose is destroyed.

Figure 2. Limited destruction of the upper lip.

In the first the extremity of the nose (septum and wings) is destroyed. There is no other alteration. The rest of the nose and the upper lip are intact.

The second subject has undergone a limited destruction of the middle of the upper lip. A portion, in the form of an obtuse angle with its summit bordering on the septum, has disappeared, throwing into view the gums and teeth which remain intact. The borders of the lesion are clean, and appear cicatrized; the nose seems pointed, and the two wings are strongly spread out.

Figure 3. The upper lip is eaten away.

Figure 4. Cicatrization following necrosis of the upper jaw.

The third subject expresses an alteration most grave. The upper lip is devoured, likewise the nose, uncovering the gums, which are red and bleeding.

The teeth are complete, but the end of the nose has disappeared; this is of abnormal shortness and appears too high.

The fourth pottery is even more interesting. There has been necrosis and loss of the superior maxilla, which has undergone a retraction over the inferior. A cicatricial tissue has formed, tight and inextensible, which leaves the teeth uncovered and obstructs the entrance of the nostrils. The lower eyelid of the right eye, held by the cicatricial tissue, leaves uncovered the ocular globe, while that of the left eye is normal.

The last pottery of this series represents a mother, who holds her infant in her arms. In her case also there exists a loss of the upper jaw. But here the nose is destroyed at its root; the extremity, intact, is turned up. This form of nose has been well described by Fournier, the syphilographer of France.

Similar potteries are not rare. They exist likewise in the Museum de la Plata, Argentina, South America. A beautiful collection of photographs of this last Museum is on exhibition at the

Trocadero. You can see there a subject who has lost his nose in like manner; a person whose face is covered with soft tissue, which is drawn tight, and reminds one of sclerous tissue. The mouth is puckered and reduced to a very small aperture, the lips have lost

Figure 5. Nose lost at the root.

their apparent elasticity, as if they could neither be opened nor closed, and the teeth remain uncovered. Certain subjects of lupus to-day offer this very aspect.

In America, I have for many years made a very minute examination of all such potteries, mostly derived from Chancan or Chimbote, Peru. Some of them were buried with the mummies of Ancon, the oldest cemetery of Peru, where most of the thermal springs were located. Here surely would congregate, before death, the diseased of those ancient races, and many must have died there on the very spot. However, it has been impossible to locate the exact mummy to which each piece of pottery belongs, through the fault of the explorer. I have also examined all the Ancon mummies in the United States, and caused to be examined by the eminent anthropologist, Dr. Emile Schmidt, all those of the Leipzig Museum, where is to be found the finest collection of American objects in the whole of Europe. The Leipzig authorities in collecting specimens even *killed* a Guayaquis Indian in South America to obtain his skull! Their agent recently paid in Lima as high as one hundred dollars in gold for one of these little pot-

teries, which I was myself trying to get possession of. There is not a pottery with deformed face now in Peru which can be bought. Leipzig has the market for them cornered. The finest collection of these pots, however, can never be obtained, as it belongs to a woman who will not sell. She has a thousand specimens, of which she has promised me photographs.

I also had Dr. A. Bastian, Director of the Royal Museums of Berlin, go over his collection of mummies and pots in Dr. Edward Seler's American Department, for evidence of pre-Columbian diseases. But in none of all the mummies I examined, or caused to be examined, was there found even a trace of the disease which M. Virchow claimed was represented on some of the huacos potteries. M. Virchow argued against me for five years in the Berlin Anthropological Society. He believed himself able to recognize on those potteries signs of leprosy. In these discussions Dr. Leopold Glück, of Sarijivo, Bosnia, and Dr. Armauer Hansen, of Bergen, Norway, stood with me in concluding that they did not represent leprosy, for the hands and feet were never shown to be diseased, as would have been the case with lepers. I finally proved to the satisfaction and recorded acceptance of the anthropological world that those representations were really only what is shown still further by the evidence of these five Trocadero potteries which I reproduce here, and that is, that syphilis and lupus occurred together in the same individual. This opinion has been now concurred in by the authorities of the Smithsonian, of the Museum de la Plata of South America and by the Spanish authorities, because on these potteries, as on the others which have been critically examined, there is shown the upper lip retracted or destroyed, a character which is seldom if ever seen in leprosy; the faces, too, of these pots never present tubercles, tubers or the appearance called leontiasis (*lion-face*), which belongs to tubercular leprosy, and which surely would have delighted the old Peruvian artists to depict in clay; but, most important of all, the hands of all the pottery subjects are always represented intact and perfect, while in lepers they are so often mutilated. Those artists of old Peru conscientiously would never have neglected the horrible appearance of tuberculation of the face or the clubbed and clawed hands of a leper. It would have pleased them beyond measure to picture such deformations on the anthropomorphous image supposed to represent the *soul* of the individual buried. Those little gems of human representation were true im-

ages of the departed, and they would not have made them false. Amputation of hands was never represented on a pot, because artificial hands were necessary to carry the drinking water to the lips. On not one single pot anywhere in the whole Museum world is there represented a mutilated hand or a tuberculated face. This in itself is conclusive evidence that leprosy was *not* pre-Columbian in America.

These potteries of the Trocadero offer more perfect signs yet in favor of syphilis and of lupus representations; those multiple lesions of the nose are characteristic of syphilis, or of syphilis and lupus combined.

If there is any doubt of it, it is not in favor of leprosy but of lupus, as is shown in the subject Fig. 4. Even this subject derived from the Museum de la Plata, with retraction of the skin of the face, might equally be afflicted by lupus.

A last argument is furnished us by an examination of the thousands of pre-Columbian bones of American graves. Not one offers a leprous lesion, as we find them represented in the graves of the cemeteries of the "Madeleines" of France, where are found the little bones of leper hands as if *melted away* to a fine thread, but never so in ancient American graves. Quite a number of the American bones from ancient American graves, undoubtedly pre-Columbian, on the contrary, are syphilitic.

We all must admire the dexterity of those old Peruvian artists, who have given us such good representations of the ulcerative lesions of these diseases.

Besides the evidences of an "eating disease" on the faces of these clay vessels of the graves of Old Peru, there are a number which appear as if the nose and upper lip had been cleanly cut off with a knife.

Here is a photograph of one such, which Prof. Bastian, of the Royal Museum of Berlin, kindly sent me (Fig. 6). There are others with this same exhibit in the Bandelier Collection of the American Museum of Natural History, New York.

Mr. Wilhelm Von den Steinen, to whom the original of this pot belongs, says: "It is from Chimbote. The tip of the nose and the upper lip are destroyed, the cheeks 'flown out' and furrowed with wrinkles or scars." I submitted this photograph, after Prof. Bastian had sent it to me, to Dr. Hansen, of Bergen, Norway (the discoverer of the leper-bacillus), and he replied that "it did not present signs

of leprosy." "There are no tubercles on it," he said, "and no phenomena of anesthesia."

This photograph has always appeared to me as if the person it represents might have been mutilated by a surgeon's knife for lupus.

Figure 6.

Dr. Ugaz, the best authority in Peru to-day on this last-named disease, concludes an interesting article, "Etiologia topografia y tratamiento de la Uta (lupus)," as follows: "Uta (gallico, llaga, Ilianya, tiacaraña, Qquespo Spondyle) of Peru is bacillary tuberculosis, generally localized in the uncovered parts of the skin (tuberculo-derma), and its *only* treatment is endermic and *surgical.*" My own conclusion is that this Uta, gallico, llaga, etc. = pre-Columbian lupus (with or without complication with syphilis), is the disease represented on the huacos potteries, for some of those specimens represent the effects of the surgical treatment of that disease, the *cutting off of nose and upper lip.*

It is highly probable that some of the deformations of those ancient Peruvian figures were intended to represent lupus and syphilis combined and not leprosy. For, as I said, Ancon, the pre-Columbian graveyard of Old Peru, was also the place of baths where the "luposos and sarnosos" congregated for *curative* treatment.

Had Ancon been a resort for lepers, somewhere in an European or American Museum we should be able to discover a *mummy* showing loss of fingers or toes, for most lepers are thus mutilated. But,

quite to the contrary, no such disfigurement of pre-Columbian remains up to this time has been found in any Museum of the world. I have searched all over for such and without success. Moreover, had there been lepers in pre-Columbian Peru, they surely would have gone to those baths along with the luposos and syphilitics. Only the syphilitics could have been cured, while the luposos and lepers, being incurable without surgery, would have died there. Thus the absence of leper remains from the graves of Ancon is double proof that leprosy did not exist in pre-Columbian Peru.

In determining in some of these representations of diseases on these ancient potteries what disease each one is, it must not be overlooked that even in the living subject the diagnosis between leprosy, syphilis and lupus is sometimes most confusing to a physician and even to a trained leprologist. This is especially true when the patients belong to degenerate or dying-out races. How much greater then must the difficulty be to determine the identity of one of these diseases whose representation was carved on the face of a small clay image by an artist who was not a medical man. We must observe, moreover, that in the representation of a disease on the clay figure of a man, intended to record what belonged to the corpse, and to be forever buried with it as its "double" or *soul*, the failure to show in that clay figure a mutilation of fingers or toes or tuberculation of face, the most usual deformities of leprosy, should indicate to us that the disease which the handicraftsman had illustrated was not leprosy at all but some other disease.

There is a specimen of ancient Peruvian pottery in the Royal Museums for Ethnology in Berlin which I have figured in the *American Journal of Cutaneous Diseases.* These photographs originally were given to me by Prof. Bastian, of the Berlin Museum. It is the figure of a man, apparently a dwarf, whose skin is covered with tuberculous lumps. The question is, What does it represent? And, more especially, does it afford any proof of the existence of either syphilis or leprosy in ancient Peru? It is quite clear that the artist has copied from some living subject, and we have at any rate offered for our inspection a very early delineation of the disease. This pottery is probably a thousand years old.

Jonathan Hutchinson, F.R.S., of London, to whom I submitted the photograph, argued with me that there is no reason to consider the disease leprosy, for the man is scratching very vigorously and clearly has no anesthesia of the skin, which would belong to him

had he leprosy. His head is thrown back. Nor in the tuberose form of leprosy are the tubercles ever so freely developed on the trunk as is here shown. Mr. Hutchinson believed that the figure represented Molluscum fibrosus, a disease of skin which does not exist in Latin America to-day; and had it existed there in pre-Columbian time, would it not be found in Peru to-day? Besides these objections to Mr Hutchinson's diagnosis there is the upper lip shown to be eaten away, as is so common in the other Peruvian potteries. Molluscum is not essentially pruriginous, but scabies or pediculosis might have been present to account for the itching. To my mind, it is another instance of *lupus representation.*

I have also nine representations of the grave potteries of old Peru. The first is indentical with a huacos pot in the Field Columbian Museum, Chicago, a photograph of which was kindly sent me by Dr. Dorsey, and which I published in my article, "No Evidence in America of Pre-Columbian Leprosy," in the *Canadian Medical and Surgical Journal*, March, 1899 The 4th, 7th and 9th are identical with those of the Bandelier Collection of the American Museum of Natural History, which I published, with permission, in the *Journal of the American Medical Association*, in an article entitled "Pre-Columbian Leprosy," April, May and June, 1895, and in the *Verhandlungen of the Berlin Leper Conference.* The 2d, 3d, 5th, 6th and 8th of these images are representants of lupus and syphilis in their deformations. It should be noticed, as we proceed, that in every case the fingers are represented normally.

As to the question of pre-Columbian origin of these vases, those must be regarded as *certainly* pre-Columbian which have been found with a certain gold ornamentation, the gold brow feather, the exclusive ornament of the Inca family. I have seen these "brow feathers" in the collections in the Ethnological Museum known as the Bässler, formerly belonging to Herr Krätzer, of Lima, and also in the new collection of Mr. Krätzer. Besides some of the images were buried with diseased bones, notably one sent up by Mr. Bandelier, the explorer, from Lake Titicaca, of Peru, to the American Museum of New York, which was dug up along with a pre-Columbian Pachacamac syphilitically *diseased* skull. I took a photograph of this skull to accompany my contribution to the Berlin Leper Conference (article entitled "The Question of Pre-Columbian Leprosy in America, and Photographs of Three Pre-Columbian Skulls"). Dr. Patron, of Lima, and Dr. Manuel A.

Muniz, of the same city of Peru, have studied the subject of these potteries, so far as they relate to leprosy. Dr. Patron says, "Leprosy has remained an unknown thing to the native born of Peru, as is evidenced by the lack of a word for leprosy in the Kechuan and Aymaran languages." When leprosy appeared with the invading Spaniards and negroes, a phrase became necessary to be added to the language. Bertolini, in his dictionary of Aymara, gives for leprosy the word "Caracha," which means "itch." And Gonzales Holguin, in his book on the Ketchua language, defines "Liutlasca Caracha" as "itch."

Dr. Muniz wrote me that "the first introduction of African negroes into Peru was in 1536." "The first negro was with the *thirteen* of the Isle of the Cock before the conquest of Peru. There were maroon negroes in Peru in that same year. The king granted to Pizarro the privilege of importing negroes." These Spaniards and negroes introduced leprosy to Peru. Dr. Patron thinks that the diseases which can produce mutilations like those seen on the pottery are syphilis, boils, verruga-Peruana, or Peruvian warts, a disease with fever and peculiar to Peru (this is described by Odriozala, Paris, 1898, as Maladie de Carrion, for Dr. Carrion, a pupil who died from self-inoculation of it to determine its specific characters), and "Uta" (lupus). The word "Uta" means "to eat away," and would naturally be applied to a disease which destroys the tissues. The disease is called variously in different localities: Gallico ("French Disease"=the Spanish name of syphilis when it first appeared in Spain); llaga, Ilianya, Tiac—Araña and Qquespo. All the best authorities attribute this disease to the sting of insects, or by deposition of their eggs beneath the skin. Insects are especially attracted to the mouths and noses of sleeping persons, and those parts especially would be most liable to be inoculated by such a disease as lupus, which has for its germ the tubercle-bacillus of Koch, for aviary tuberculosis in Peru existed long before human tuberculosis was known. The Indians of the Peruvian Sierras are extraordinarily susceptible to lung tuberculosis directly they are transferred to the coasts, while in altitudinal Andes this phase of this pre-Columbian disease does not appear. Dr. Patron's great remedy to-day for Peruvian lupus is cauterization with the Paquelin battery. In other words, all authorities agree on the cure of it by no other means than the *knife* or by burning it out.

Mr. Bandelier, of the American Museum, in reply to my question whether the Peruvian images labeled Chancan and Chimbote, which he had sent up, were to be considered pre- or post-Columbian, said that some of them were and some were not.

The question of the pre-Columbianism of these pots, which arose when I brought them to the attention of the Berlin Leper Conference, was afterwards thoroughly discussed in the Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte (see *Zeitschrift*, 1897, 1898 and 1899), by eminent *Americanists*, such as Polakowsky, of Berlin; A. Stübel, of Dresden; Reiss, of Berlin; Dr. E. W. Middendorf, Dr. Edward Seler, of Berlin; Dr. Marcus Jiminez de la Espada, of Madrid; Dr. A. Bastian, the Director of the Royal Museums of Berlin; Prof. Virchow, President of the Society; Dr. Carrasquilla, of Bogota; Dr. Lenz and Dr. Lehman-Nitsche, of La Plata Museum, and Von den Steinen, etc. I brought before these eminent and learned gentlemen all the evidence furnished me by Mr. Bandelier and the anthropologists of America. Mr. Bandelier had written me that all his "finds" were

Figure 7.

pre-Columbian, and especially described a huacos pot representing a human amputated foot, which I had described in my original paper. The fact that it was a diseased foot would indicate that it had not been amputated as a punishment "for crime," as Dr.

Carrasquilla, of Colombia, South America, had thought. That it is a disease representation is shown by the toes of the clay figure being elevated from the ground, as if the sole of the foot was greatly swollen. This Pachacamac foot-pot was dug up from a grave twelve feet deep; not a bead nor a piece of glass or copper was ever found in that pre-Columbian burial-ground. This is an indication of pre-Columbianism. Moreover, this pot, which I reproduce here, shows the bone protruding and the flesh cut away, just as would appear on a foot that had been amputated, for the flesh flaps must be thus provided to cover the stump of the leg. Mr. Bandelier wrote me as follows of this peculiarity of the figure: "I think that the figures represented without feet ought to be considered as *amputated*, so that they have nothing to do with the question of leprosy or syphilis."

Certainly a people that could trephine a skull as admirably as these same Incas, as is shown by one photographic specimen sent me from Peru (which I here reproduce for purpose of illustration), could just as well amputate with the stone knife a foot properly (see "Pre-Columbian Surgery," Ashmead, *Univ. Med. Mag.*, 1896).

Figure 8. Trepanation of the Incan Epoch (Squier's skull).

This Fig. 8 shows a trepanation of the Incan epoch: A cranium of Yucay. Nelaton and Broca determined that it belonged to the

indigenous race and that it was ante-mortem. Broca concluded that such an operation was performed for extravasation of blood in the cranium from a number of causes—wounds, punctured fracture, violent inflammation, suppuration, delirium, coma, etc.—just as is done by our surgeons to-day.

I have also pictures of ten huacos potteries of La Plata Museum, Argentina, which Dr. Lehman-Nitsche submitted to me. As will be seen also by a reference to those of the Bandelier Collection of the American Museum, New York, while amputation of the feet is often represented, in not one single pot is there a hand amputated. Dr. Polakowsky raised the point that if these amputations were due to disease there should be representations of amputated hands as well as feet. But he overlooked the important fact that then the soul of the departed could not reach out his hand for the wine or water-bottles which are necessary for his future life in the grave or for his four days of journey to Paradise. The whole intent of putting these little bottles in the grave with the corpse is to keep death from becoming definite. A *handless* soul representation would destroy their religious belief. Therefore, even if the hand of the corpse was amputated, they would put on the image they buried with that corpse, *good hands* to help the individual in the other world.

Dr. Carrasquilla was of opinion that these amputation representations do not treat of disease at all, but of punished criminals; that for little faults they cut off the nose and upper lip, and when they punished "relapsers" they amputated also the feet, for the purpose of hindering them from committing new crimes or to keep them from running away.

Dr. Carrasquilla promised to send documentary proofs of this belief of his, but they were found to be totally insufficient to prove his point. Dr. William Von den Steinen has consulted all the literature of South America, like, for example, the works of Cieza de Leon, of Garcilaso de le Vega, and he has *not* been able to find indications of mutilations that prove that the representations on the clay figures have been produced by punishments which had been applied to the individuals. He believes that they refer to the representations of a disease. Mr. Stübel participated in the same belief. Mr. Bastian and Mr. Middendorf thought that they treated simply of punishments applied to criminals. Mr. Seler believed that leprosy had existed in pre-Columbian *Mexico*, because of the

well-known word "teococolitzli," which was applied to leprosy and *to skin diseases generally!* Mr. Jiminez de la Espada gave the question a new turn, that he did not believe that leprosy nor elephantiasis (its variety) had been of pre-Spanish origin in Peru; there were no documentary proofs known to him which supported such opinion, and he was not in accord with the opinion of Carrasquilla, Bastian and Middendorf, who thought they treated of criminals and beggars. He claimed that they did not apply mutilations of the body as punishment, unless death was intended to follow them, and that there were no beggars at all among the Incans, due to their social order so perfect. According to his judgment, these vessels, or better said these *votive* figures, represented a disease special to Peru, an endemic variety of tuberculosis ("llaga" or "hutta=uta"). Mr. Espada knew only one note in the old literature which refers to mutilations of the lips and the nose. "The reyezuelos ó caracas of the Isle of Puna mutilated in this way their eunuchs, for the purpose of making them unattractive to the concubines." Zarate relates it (*Histoire de la decouverte et de la Conquete du Perou*, translated from the Spanish of Augustin de Zarate by S. D. C.; first Vol., Paris, by the Compagnée des Libraries, M.D.CC.XLII, with the privilege of the King, page 25): "Le Seigneur de cette isle (de Puna) était fort crainte et fort respecte par ses sujets, et si jaloux que tous ceux qui étoient commis à la garde de ses femmes, et même tous les domestiques de sa maison, étoient eunuques; et on coupoit non seulement les parties qui servent à la generation mais pour les defigurer on leur coupoit aussi le nez." Oviedo says that the lips also were sometimes amputated. Herrera mentions no mutilation. Nor do Rivero and Tschudi (*Antigüedades peruanas*, Vienna, 1851). Bastian (*Die Culturländе des Altes America*, Berlin, 1878, Tom. 1, p. 593) says the same as Oviedo, that "they also amputated the nose and lips, so that they would not present a seductive appearance."

Prof. Virchow formulated his judgment, saying that he neither believed that they treated of punished criminals, because it was not related in the literature. Besides there exists statues of wood[1] of prisoners, derived from the Isla Chincha (Guana isles); two are well preserved, one great and the other small. The great one is on foot, the little one is represented as a truncated body. On

[1] (See Virchow, *Verhandlungen*, 1873.)

both figures the arms are held arranged behind, like a person who listens tranquilly. The large idol has a cord round the neck, which is tied in front by a coarse knot. One of the ends of the cord goes down to the stomach. The nose in both takes the form of an eagle's beak. David Forbes says these wooden idols represent prisoners holding a cord or a serpent to the neck. Forbes and H. B. Frank suppose that they have thus symbolized syphilis, a disease original to the mountains of Peru and characteristic of the alpaca or llama, an animal which transmitted it to man by unnatural vice. Neither of these idols nor those described by Weiner represent mutilated nose and lips. Therefore *all* prisoners were not punished by amputation of nose and lips. (See rich collection in La Plata Museum.)

Polakowsky divides all these vessels into groups: 1. Clay figures representing mutilation of nose, of pathologic origin; 2. Those where it is doubtful whether they treat of disease or of surgical operation.

Polakowsky does not think they treat of punished criminals, because he has searched for data in the literature and failed to find such. He lived twenty-five years in South America. Von den Steinen found in the Royal Museum of Berlin representant vases of heads and entire bodies, one of them stretched on his belly, the other on the knees or with the legs crossed. All had mutilations of the point of the nose and the greater part of the upper lip. In four of the pieces the feet were lacking, on the others the lower part of the body was covered with a cloth which enveloped it from the hips, in a manner which made one think they also had lost the feet.

Now in ceramics too: First, we have types undoubtedly of prisoners, representing a person on foot with hands behind and bound with a cord, but no other indication to show that it treats of a prisoner. Secondly, a prisoner on his knees, halting, or sitting with the feet crossed. Moreover, he has a cord tied around his neck. A *third* represents the serpent eating a certain part of his body (penis), while his hands are tied behind his back. But in *none* of these clay figures which represent undoubtedly prisoners, was there mutilation of any part of the face or of the body. The testimony of the huacos potteries, therefore, is to the effect that the Old Incans did not mutilate their prisoners by amputation of the feet. Moreover, in

these ceramics whenever amputation of feet is represented (for the flaps are shown) there is evidence of disease in the face.

Does there exist such a disease of the face, which would also affect the feet to require amputation of them and both equally? Yes! I believe that the amputated feet of the huacos potteries have relation with the mutilations represented on the face.

Mr. Ambrosetti (*Nota de Arquelogia Calchaqii* Instituto Geographico-Argentina, tomo xvii) thinks that the stumps are due to the imperfect work of the artist, like in Calchaque idols, whose feet are are not moulded in form at all. But then there are images shown stretched on the belly, apparently intended to be shown in a helpless condition! I have seen one representing a person who was dressing his stump with a cup of medicine, the stump thrown across the opposite leg; and besides there are the flaps shown and also that foot specimen itself, like a foot that had been cut off. Some of these amputated figures are represented with the hand extended for alms; some hold a stick to creep or hobble with on their knees, with their feet cut off.

In the images of the La Plata Museum, shown among the ten which I print in this article, it can be seen by the originals (for all the kneeling figures are without feet, the ends of their limbs showing flap-stumps as if amputated, which cannot be seen by a front view) that in no case is amputation represented without the image showing a diseased face. Now the ancient Incans cut off the hands and ears of prisoners, but not the feet. Yet this mutilation *of hands and ears* is not shown by a single specimen of pottery that I have seen, and besides I believe that they never buried a *clay soul-figure* with such a criminal. *They wanted him to die.* The pot buried with him would keep him alive.

In a report of the Viceroy, Dr. Martin Henriquez, of the year 1582, which mentions the manner of government of Peru, the customs and usages of the Incas, and where it is said in a general way that amputation of limbs was a punishment of criminals, he goes on to say: "But in my opinion such amputations were no simple bodily punishment which left the sufferer alive, but a kind of capital execution like hanging, or other like." The text, which is here translated literally, says: "Executions were public and very crude. Some were precipitated from rocks (of Andean precipices), others had their limbs amputated, etc."

Von den Steinen says: "As to the mutilations of the legs, whether

it be amputation or disease we have no case made out. In all Peruvian vases where feet are represented they are easy to be recognized as such. The accuracy in the rendering goes even so far that in some representations of persons with tucked-under legs the form of the feet is expressed on the bottom of the vase. That the Old Peruvians liked to find in their vessels the forms of persons affected with remarkable manifestations of disease is shown also in the Berlin collection, by the large number of them blind, one-eyed, with lop-sided jaws, etc. As to the finding places of these vases, they are unfortunately not safely established, the greatest part has the indication of Chimbote, and besides there is Trujillo and Chancay."

I point out, in conclusion, here that the influence of cold of the Andean heights might have had to do with the necessity of amputation of feet. There was a great deal of barefoot walking in Incan climates, while the hands would be better clad. We must renounce, however, the giving of a positive judgment as to the mutilations of the feet of Old Peruvians. So far no other explanation has been found but a pathological one.

Prof. Bandelier wrote me from Lake Titicaca, where he was engaged in explorations for the American Museum: "All the Pachacamac remains, a few specimens perhaps excepted, which I cannot now remember, belong to the so-called Yunca (hot country) or coast Indian type of artifacts, and they are certainly anterior in date to 1532. I do not wish to be understood to say that all the Pachacamac finds to be made, or made previously, are not post-Columbian; but the site where I caused the excavations to be made and the depth at which the objects were taken out, point to the conclusion that my finds are indeed pre-Columbian, or at least with very few exceptions only. The human foot alone and in appearance amputated is not rare among coast pottery, and the Museum must have another one sent by me from Lambayeque, with its sandal perfectly normal as well as handsomely ornamented. I remember having seen other specimens of the same description. But none of them were deformed as the Pachacamac foot is.

"The deformed faces on the pottery are generally regarded as representations of syphilis, and I never heard leprosy mentioned in connection with them."

This is what I read of the ancient languages of Old Peruvians as written in their graves: There was never a migration of these dis-

eases from Asia, nor did their religious beliefs about the soul emanate from Asia. The surgery of ancient America was not of Asiatic derivation. The civilization or culture-growth of ancient Peruvians was purely an American institution which had developed from preëxisting savages on this hemisphere.

NEW YORK, 333 W. 23d St.

Stated Meeting, December 18, 1903.

President SMITH in the Chair.

The list of donations to the Library was laid on the table, and thanks were ordered for them.

The decease of the following members was announced:

Rev. Henry Clay Trumbull, D.D., at Philadelphia, on December 8, æt. 73.

Dr. Gustave Schlegel, at Leyden.

Mr. Rosengarten presented a communication on "The Earl of Crawford's MS. History in the Library of the American Philosophical Society."

Dr. Leonard Pearson was introduced by the President, and presented a paper on "The Animal Industries of the United States."

The President delivered his "Annual Address."

THE EARL OF CRAWFORD'S MS. HISTORY IN THE LIBRARY OF THE AMERICAN PHILOSOPHICAL SOCIETY.

BY JOSEPH G. ROSENGARTEN.

(*Read December 18, 1903.*)

In the Library of the American Philosophical Society there are four folio MS. volumes, in old binding with clasps, but with nothing on the Library records to show how they ever got there.

The 1st volume is labeled "Account of Some Campaigns of the British Army from 1689 to 1712, and Journal of a Campaign under Prince Eugene on the Upper Rhine, and Miscellaneous Papers."

The 2d and 3d volumes, "Journal of a Voyage from the Thames to Russia, and of Campaigning with the Russian Army, 1738–9."

The 4th volume, "Journal of a Campaign with the Russian Army against Turkey, 1739."

They are all in admirable condition, in uniform clerkly clear handwriting, and with a large number of fine maps, executed by Henry Köpp by order of the Earl of Crawford, and inscribed to the King of England, Lord Loudoun and other noted persons high in command in the British army.

The 1st volume contains:

1st. "A Short Treatise of Fortification and Geometry," pp. 33.

2d. "A Method of Discipline proposed for the Behaviour of a Regiment of Foot upon action," pp. 29.

3d. "An Account of the most remarkable Transactions which happened in the Campaigns I made from the Year 1689 to the Conclusion of the Peace of Ryswick in 1697." It begins as follows: "The Regiment I served in is very well known by the Title it bears of the Royal Regiment of Foot in Ireland, from which Regt. I may without Vanity say our British Infantry had the Groundwork of their present Discipline." It describes Schomberg's Irish campaign of 1689, pp. 12; then the campaigns of 1694–5–6–7, pp. 14.

Then, 4th, The Campaigns of 1702–12, pp. 63.

Then, 5th, comes "A Journal and Remarkable Observations during Three Campaigns made by a friend to the Trade of War, in Three Volumes. Vol. First: Journal of a Campaign made with the Imperial Army under the Command of Prince Eugene of Savoy on

the Upper Rhine in the Year 1735." It begins in London, May 24, 1735, pp. 87, and closes: "I shall conclude this Campaign with the inserting a few usefull Papers I collected during the Operations of it, and of the following (I dare venture to say) exact Plan of the Country we march'd over." Then follow twelve well-executed maps or plans giving the successive positions of the armies, the last an elephant folio map of the Rhine from Coblenz to Carlsruhe.

6th. "The following March Root [*sic*] ordered by Prince Eugene . . . . I insert as a Model . . . . of a very difficult part of Duty in the Trade of War," pp. 5.

7th. "Un detail exact et bien calculée [*sic*] de ce que coutoit par mois en 1681 la plus florissante marine que la France aie ene," pp. 8.

8th. "Un Traittes Touchant Les Conquêtes qu'on pourroit faire en Amerique sur la Maison de Bourbon au cas que la Guerre devienne generale et qui seuls peuvent retablir l'Equilibre de l'Europe," pp. 6.

9th. "Tabulated Lists of the French Army in 1735."

10th. "Reflexions sur les Evenemens de la Mosellé," pp. 2 [imperfect].

11th. "Treaty and Cartell made and Concluded between His Imperial and Catholick Majesty on the one part, and his most Christian Majesty on the other, concerning their Prisoners of War in their Armies on the Rhine, 1735," pp. 16.

12th. "The Troops in the Black Forest, Friburg and Brisac—Specifications of the Imperial Regiments 1735. A List of the Imperial Regiments both Horse and Foot, the Names of the Comissioned Officers, Comanders and Agents, together with the Numbers of men in each Compleat Regt., and the places where they are now," pp. 24. On the fly leaves are a tailor's bill in German and some heads of letters, etc.

The 2d and 3d volumes are labeled "Journal of a Voyage from the Thames to Russia and of Campaigning with the Russian Army." It begins at Gravesend, April 13, 1738, and contains personal expenses, phrases in English, German and Russian, maps, drawings of scenes, camps, etc., and a sermon on Peter the Great. The 2d vol. pp. 287, the 3d vol. pp. 398. There are eighteen maps of sieges, operations, defences of Belgrade, etc., etc. One of the maps is dedicated to George the Second.

The 4th volume opens with

1st. "A Tabular List of the Imperial Troops in 1737," followed by (in French)

2d. "Journal of the Hungarian Campaign of 1737," with General Orders, Maps, etc.

3d. "Relation des Operations de la Campagne 1738," by Chevalier de Forrestier, Captain of the Regiment of the King's Infantry.

4th. "A Diary of the Army under the Duke of Lothringen, 1738–9" (in German).

The bills for personal expenses are made out to the Earl of Crawford, and this is the only identification. These volumes were no doubt prepared by his secretary, under his direction, as material for establishing the record of his services for preservation in the family archives, and for use in a posthumous biography.

The author and owner of these MS. volumes was John Lindsay, twentieth Earl of Crawford. The *National Dictionary of Biography* gives, in Vol. 38, p. 305, etc., the following sketch of his life: 1702–1749. "After attending the Universities of Glasgow and Edinburgh, he was sent in 1721 to the Military Academy of Vaudreuil, Paris. In 1726 he was appointed to a company in one of the additional troops of the Scotch Greys. He early acquired a reputation for resolution and daring, and while not neglecting intellectual accomplishments, attained exceptional proficiency in athletic exercises, especially in shooting, fencing, riding and dancing. On the disbandment of the additional troops of Scots Greys in 1730, he . . . . devoted his more serious attention to military studies and his leisure to boating and hunting. On January 3, 1732, he obtained command of a troop of the 7th Queen's own regiment of dragoons, ... in February, 1734, he obtained a captain lieutenancy in the 1st regiment of foot-guards, and in October a captaincy in the 3d regiment of foot-guards, but being desirous of acquiring practical acquaintance with the art of war, he got permission, in 1735, to join the Imperial army under Prince Eugene. He specially distinguished himself at the battle of Claussen on October 17. In April, 1738, he sailed from Gravesend to St. Petersburg, and having received from the Czarina Anna the command of a regiment of horse, with the rank of general, he, after a perilous journey of one thousand miles, joined the army of Marshal Munich, then engaged in a war against the Turks. He soon acquired great proficiency in the mode of warfare practiced by the Russians. . . . . After the retreat of Munich to Kiow, Crawford left him and joined the Imperialists near Belgrade. When the army went into winter

quarters, he accompanied Prince Eugene's regiment to Comorn, and thence proceeded to Vienna, still occupying his leisure principally in military studies. In April he rejoined the Imperialists at Peterwardein under Marshal Wallis. . . . . He left in August, 1741, and returned to England. In July, 1731, he had been made colonel of horse and adjutant-general; in October, Colonel of the 42d Highlanders, and in December, Colonel of the Grenadier Guards. . . . . In May, 1743, he joined the army under the Earl of Stair at Hochstet, when he was made colonel of the Scotch troop of horse guard and adjutant-general. At the battle of Dettingen, on June 16, he commanded the brigade of life-guards, ... with the rank of brigadier-general. He joined the allied army near Brussels in the following May, and at the battle of Fontenoy, April 30, 1745, he succeeded . . . . in so covering the retreat that it was effected in perfect order. On 30th May following he was made a major-general. On the outbreak of the rebellion in Scotland in 1745, he was appointed by the government to the command of six thousand Hessians, with whom he secured the towns of Perth and Sterling and the passes into the lowlands. . . . . He rejoined the army in the Netherlands. On the day of the battle of Roncroux, October 5, 1746, he was surprised while reconnoitring, but coolly assuming the character of a French general, ... was permitted to pass unmolested. . . . . In December he was appointed to the command of the 25th foot . . . . on May 20, 1747, to that of the Scots Greys, and on September 20 was made a lieutentant-general. . . . . Crawford joined the Duke of Cumberland in the campaign of 1748. . . . . Returning after the peace to London, he died there September 20, 1749."

The *Dictionary of National Biography* refers to "Memoirs of the Life of the Right Hon. John Lindsay, Earl of Crawford and Lindsay, by Richard H[should be R]olt, London, 1753, 4to," reprinted in 1769, under the title "Memoirs of the Life of the late Rt. Hon. John Earl of Crawford, describing many of the highest achievements of the late wars," and "Lord Lindsay's Lives of the Lindsays, London, 1849, 3 volumes, 8vo." In Vol. 2, p. 235, etc., there is a sketch of his life, and on p. 237 a note says: "The diary of this journal [*i. e.*, from Petersburg to General Munich's quarters], dictated by Lord Crawford and corrected by his own hand, a large folio, is now in my possession, with various other journals and military MS., the bequest of my kind relative, Lady

Mary Lindsay Crawford, sister of the last Earl of Crawford of the Byres line."

The full title of Rolt's book is "Memoirs of the Life of the late Right Honorable John Lindesay, Earl of Craufurd and Lindesay, Lord Lindesay of Glenesk and Lord Lindesay of the Byers, one of the sixteen Peers of Scotland, Lieutenant General of his Majesty's Forces, and Colonel of the Royal North British Grey Dragoons, by Richard Rolt, author of The True History of the Late War. London, Printed for Henry Köpp; and sold by Mr. Newberry, in St. Paul's Church Yard; Mr. Owen, at Temple Bar; and Mr. Paterson, in the Strand. 1753, 4to, pp. 432, with appendix."

Much of this book is a reprint of the principal parts of the four MSS. volumes in the Library of the American Philosophical Society, viz.:

Chapter 2. An account of the rise of the war between the Emperor and France in 1733 to the campaign on the Rhine in 1735, when the Earl of Craufurd served as a volunteer under Prince Eugene and Count Seckendorff; the action at Claussen; and the end of the war.

Chapter 3. The rise of the war between the Russians and the Turks in 1736, wherein the Imperialists were auxiliary to the former; the state of those empires, with a short account of the campaigns in Tartary and Hungary in the years 1736–7.

Chapter 4. An account of the Earl of Craufurd's preparations for the Russian campaign of 1738; his voyage to St. Petersburg; his reception at that Court, and his journey from thence to the Russian army in Bessarabia. His reception by Feldt-marshal Munich; an account of the Tartars; as also of the campaign in Turkey, and the Earl of Craufurd's journey to the Imperial army in Hungary. His reception by the Grand Duke of Tuscany, an account of the campaign in Hungary, and his lordship's journey to Vienna.

Book III, Chap. 1. The campaigns of 1739, containing the journal of the campaign in Hungary, together with a general plan of the whole, which was generally printed for this work by his Royal Highness Prince Charles of Lorraine; as also an account of the same campaign written by the Earl of Craufurd, with a description of the battles of Krotza and Panscora; to which is added a short detail of the Russian campaign, with his lordship's observa-

tions on the whole and several plans drawn under the direction of his lordship.

No. 1. The journal of all the motions made by the Imperial and Turkish armies, from the opening of the campaign in 1739 until the peace of Belgrade; together with a plan of operations. . . . .

No. 2. A description of the battle of Krotzka, ... with observations . . . . by the late Earl of Craufurd.

Chapter 2. A short introduction to the siege of Belgrade; a journal of the siege, wrote under the direction of the Earl of Craufurd.

Chapter 3. . . . A journal of his voyage up the Danube from Belgrade to Vienna. . . . .

Book IV, Chapter 1. His journey to Milan and Genoa in 1743, when he joined the Austrian army commanded by Marshal Traun . . . . his campaign of 1743 in Germany and the battle of Dettingen. . . . .

Chapter 2. . . . The campaign in Flanders in 1744 . . . . his opinion at a council of war. . . . .

Chapter 3. His remarks on the opening of the campaign in 1745, and his account of the battle of Fontenoy.

Chapter 4. His conduct toward suppressing the rebellion in Scotland. The campaign of 1746 in the Netherlands, with a particular instance of the respect shown to his lordship by Marshal Saxe . . . . his remarks on the battle of Roücoux. A short account of the campaign of 1747 in the Netherlands, and of that of 1748.

The author of the maps, both in this Life and in the MS. volumes, is Henry Köpp, for whom the Life was printed. He was secretary and draughtsman for Lord Crawford, although Rolt says in his Life of Crawford, on p. 87, that "the Earl's greatest amusement (in his periods of inactivity) was in revising his journal . . . . making observations of what he had seen, and in embellishing the plans of the marches and encampments of which he had been a spectator."

Rolt says (p. 116, etc.) that he sent eleven horses to Vienna, following (on the advice of Prince Cantemir, the Russian Ambassador to England) five months later, with three servants and as many horses and three friends, who were desirous of acting as volunteers. . . . . One of the maps, that of the operations on the Danube in the campaign of 1739, is dedicated to General Oglethorpe by Henry Köpp; three others printed in the Life, and identical with those in the MS. volumes, are dedicated to the Earl of Loudoun:

"A View of the Imperial and Turkish Armies . . . . at Winscha"; but even more curious is the "Plan designated by the Earl to shew the disposition in w^ch his lordship conceived the Imperial Army might have been formed, on its Junction with Count Neuperg's Corps, during the night between between the 22nd and 23rd of July 1739; in w^ch situation . . . . it would have been more eligible to have renewed the Battle against the Turks, on the 23d, than for the Imperialists to retreat as they did in the night time of the 23d."

There are, however, many original maps in the MSS. volumes, not reproduced in the Life, no doubt owing to the expense. At p. 430 of the Life, Rolt says Lord Craufurd "designed and drew plans with such great accuracy, that he beautifully represented all the heights, and the hollows; every small break, every ditch, hedge, bush, and other obstruction, which could in the least, incommode an army forming in the line of battle, in its movements; whereby any person, a little acquainted with drawing, could easily perceive which of the armies had the advantage of the ground, and which of them had improved it the most for their own security." Further, "He was of the opinion that it would be a great advantage . . . . to introduce archery into our armies . . . . each battalion should have from twenty to four or five score able bodied men, who had been trained to shoot at butts, from their youth . . . . to encourage young men to train themselves to the use and exercise of these weapons . . . . to . . . . be detached a little before the front of the first line to throw their arrows among the enemy's cavalry, after which they should lay aside their bows and quivers, and fall in with their small arms, with their battalions." He also advised the use of heavy firearms "such as were used by the Spaniards under the Duke of Alva, which they levelled upon the rest of a fork fixed to the piece by a swivel, for these arms carried a very heavy shot and did execution at a great distance."

How did these MSS. volumes come to this country and to the Library of the American Philosophical Society? Were they used by Rolt in preparing his Life of Lord Crawford, or had Lord Crawford a number of copies of his MSS., all enriched by maps and plans, and bound under lock and key? These curious volumes ought to be in the Library of the United States Military Academy at West Point, or in that of the General Staff College, soon to be opened in Washington, for they constitute a contemporary docu-

ment of value to students of military history. The Philosophical Society would no doubt be glad to exchange them for books better suited to its peaceful scientific pursuits and to its legend, prescribed by its great founder, Franklin, "For promoting useful knowledge."

OBITUARY NOTICES OF MEMBERS DECEASED.

JOSEPH MILLER WILSON, A.M., C.E.

(Read May 1, 1903.)

To meet Joseph M. Wilson in ordinary intercourse afforded an opportunity to learn of the good, true and beautiful in human nature; to know him better, in relation to the sciences and arts, was a privilege fraught with instruction, aid and a constant progression onward and upward toward greater knowledge of things as they are; to know him spiritually, to recognize the Holy Spirit of Truth within him dominating all else, was to feel the influence of that more profound, ennobling, holier enlightenment, based upon sincerity and Divine purpose, which "shines reflected in the human face."

To adequately appreciate the strength and force of character which lay back of his admirable work, it is important to recall some of the conditions which brought it about, for, from the varied standpoints of heredity, individual endowment, education and opportunity, Mr. Wilson was favored above many, and the excellent use he made of what he possessed appeals to the very best that philosophy can recognize.

Joseph M. Wilson was a worthy member of a long line of men eminent in professional walks of life, notably as experts in the engineering profession, each of whom had made his mark in public service by ability founded upon integrity, and inspired by a progressive spirit which, while ignoring nothing in nature, conserving the best from the past, ever led onward toward the further betterment of men and things.

His earliest American ancestor was Robert Gibbes (1644–1715), who came from his native place, Barbadoes, to the Province of South Carolina; was Chief Justice of that Province (1708) and Governor (1710–1712). His great-great-grandfather was James Wilson, an engineer and architect of Stirling, Scotland, whose son John Wilson (1755–1798) was Lieutenant in the Seventy-first British Foot (Highlanders), and served throughout the American Revolutionary War as an engineer under Major Moncrief, of the Royal

Engineers; was wounded at the siege of Charleston; later on married there a daughter of Dr. Robert Wilson, a prominent physician of that place, and eventually returned to Scotland.

In the next generation, John Wilson (1789, Scotland–1833, America), the grandfather of the subject of this sketch, having completed his education at the University of Edinburgh, returned (1807) to his mother's native land, and entered upon the profession of engineer and surveyor in Charleston. His professional thoroughness and accuracy are matters of record to this day. A map of South Carolina made by him for the State Government is yet considered the standard authority for all but subsequent improvements. He became a naturalized citizen of the United States at an early period, and during the war with Great Britain (1812) served as engineer for the construction of the works of defense of the city of Charleston; held office of State Civil and Military Engineer for South Carolina under Board of Public Works (1818–1822), and in 1826 removed to Philadelphia, from which time Major John Wilson became identified, as Chief Engineer, with that extensive system of improvements for the State of Pennsylvania which during his life materialized in the Philadelphia & Columbia Railroad. Of his son, William Hasell Wilson (1811–1902), who followed directly in his father's footsteps, the important and enduring work performed by him is still fresh in the memory of many yet living. He was closely identified with the onward march and development of the Pennsylvania Railroad Company's system from its very infancy, when with his father's corps in 1826; through the formative period of the organization, when the standard was set for high achievement which has since obtained; through the Civil War period, when, as Chief Engineer of the Pennsylvania Railroad, his Department of Maintenance and Construction was called upon to preserve intact the highway itself for the transportation of armies and munitions of war as well as the general public and freight traffic; through to the end of a professional career, embracing many positions of trust and responsibility, of exceptional usefulness and duration (actual service, seventy-six years). William Hasell Wilson was finally looked upon as the Nestor of his profession, respected, honored, followed, served by many a younger man of his own corps who can to-day rise up and call his name blessed. Such were some of the influences which operated upon the subject of this sketch.

Joseph M. Wilson possessed by heredity those inestimable privileges and advantages which come from things of good repute in professional life and practice. He was keenly sensitive in upholding the high standard and family traditions thus bequeathed unto him, and he did so with a constancy and fidelity unto himself quite above the control of policies and politics, either secular or religious, which he did not approve.

Born at Phœnixville, Pa. (June 20, 1838); passed a portion of his youth upon his father's farm, Chester county, Pa.; attended private schools, and entered the Rensselaer Polytechnic Institute, Troy, N. Y. (September, 1854). After graduation, with degree of C. E. (1858), took a special course of two years in Analytical Chemistry with Prof. F. A. Genth, at Philadelphia, and in March, 1860, entered the service of the Pennsylvania Railroad Company as Assistant Engineer.

His services with that company covered the important period when the introduction of cast and wrought iron, and later on steel, in lieu of the previous wood-construction for bridges and buildings, involved much original research and experiments more or less novel to the profession. Mr. Wilson was among the early investigators to apply such in actual practice, and became a valued source of information and experience in each of the three departments of this development, viz., mathematical investigation involving the theory of strains, the development of designs, and work executed. His technical papers, published then and later on, form part of the history and literature of the profession in the United States. He held various positions in the service of the company in line of promotion, and as Engineer of Bridges and Buildings embraced opportunities involving increased responsibility by the embodiment of new ideas in construction.

He continued in that service until 1886, during which time he constructed, among many works, the original Broad Street Station, Philadelphia, which for purity in design was eminently characteristic of him.

As early as 1873, when the National Congress and citizens at large became interested in the approaching international celebration of the first centennial of the nation, Mr. Wilson at once took an active part, both as citizen and professionally. Later on, after the adoption of the design for the Main Building, which was finally erected in Fairmount Park, Philadelphia, he became associated with

the writer of this sketch in the building thereof. The Machinery Hall, the first of such dimensions and pretensions in the history of the country, was subsequently designed and erected under similar auspices, Mr. Wilson taking the leading part.

The execution of works having international significance and relations in any field of effort is apt to produce a desire, an impetus to greater comprehensive effort, embodying collateral information and more extended professional skill and practice. Mr. Wilson embodied this progressive spirit in a pre-eminent degree, his qualifications for such progress being excellent, his standard of the highest, his spirit confident. His success which followed is associated with that of his brothers, under the firm-name of Wilson Bros. & Co. (organized 1876), of which he was for many years the senior member. The scope of his work in this relation embraced a field exceptionally large, under auspices much varied, and in locations far distant in other countries; the variety of information necessary to attainment not confined to technical matters, but involving special studies of diverse character, not a few of which resulted in published papers giving much specific data for reference as well as professional opinion. Some of these papers were prepared to aid philanthropy in general, and not only those engaged in the actual construction of buildings. The scope of his work thus became in time very extensive.

Whether in the designing and erection of hospitals or of banking buildings, of comprehensive systems of shops for railroad corporations or structures for industrial enterprises; whether buildings for administrative purposes or Union Depots; whether as engineer or architect, in consultation or for expert testimony, in reference to elevated railways in cities, the water-supply of cities, or the mammoth suspension bridges connecting adjacent centres of population; whether as engineer of subways under municipal control, or as trustee for carrying out of bequests to institutes for the education of future generations; whether as President of the Franklin Institute for ten years, or as member of learned societies, both at home or abroad; whether as author of technical papers for the British Institution of Civil Engineers, London, or as an American author bringing home from France and England his study of trade-schools to improve their construction and administration here—in all these Joseph M. Wilson took part.

His constant desire was for a more comprehensive and advanced

knowledge of actual facts and powers in nature, ever with a view to their direct application in new phases of work, and this kept him in touch with investigation in many fields.

He was never visionary; imagination was not his strong point, not even in his moments of relaxation, when music (the organ in particular), painting or photography were cultivated because of the fine-art appreciation which they called for. Yet few recognized more than he what scientific research contains, potentially, for further advancement by co-operation toward the revelation of truth in unity.

From his point of view this was the highest ideal as to material things, *per se*, demanding constant touch with the progress of the age, and treatment both subjective and objective in life-work.

To study, control and utilize the forces of nature was his business in life, and he did so according to the most approved methods. If this were all, this tribute to his memory might well close at this point with one phrase: a man of high cultivation and refined feeling, an eminent engineer, whose works do follow him. With him, however, this was not all. It was not all of life to live and work—not by any means, neither in science nor religion.

To those who knew him best his personality was most sympathetic, responsive and pure in communication. He was never idle, but constantly seeking in the domain of fine art and kindred fields to gratify a refined taste and keen appreciation of the beautiful as well as the good and true, thus producing impressions which appealed through their spiritual import. These traits characterized his moral nature as forcibly as the more exact sciences and arts appealed to his intellect. His numerous descriptive manuscripts of travel, containing sketches and illustrations drawn on the spot from nature, are as a mine of wealth to those left behind. These studies of nature in its refined aspects—the optimism in nature—touched a chord which vibrated with still higher harmonies. With him the progressive spirit was not only onward but upward toward the eminent domain of theologic aspect—theology the queen of all sciences.

No one realized his own limitations better than himself, but the ideal he ever held before him was fundamentally not subject to limitations, being neither more nor less than the Divine Personality who had said unto him, "I am the way, the truth and the life. Follow me." This dictum was to Joseph M. Wilson the most profound

yet comprehensive, from any point of view, ever uttered to humanity. He endeavored to lead the life thereby called for, and his works certainly do follow him, as he followed that ideal. He was kindness and love itself, even unto self-sacrifice—constant and enduring in good effort.

In one word, the life and career of Joseph M. Wilson manifested in well-balanced harmony the two conditions, material and spiritual, which call forth the best within a man as the wisdom of this age now perceives the truth in things as they are—viz., a sound, reasonable basis (scientific) for physical needs and intellectual life in all he studied, designed, advocated and executed—this being an up-to-date application of truth as natural science now recognizes it; also, a marked spiritual discernment of truth progressive as manifested in and through the religious consciousness of humanity under the ever-active ministry of the Holy Spirit of Truth in man himself—an inner life of good thoughts, giving utterance in good words, good deeds—an example of one who did follow in sincerity onward and upward toward the brightest and best.

Mr. Wilson married (1869) Sarah Dale Pettit, daughter of Judge Thomas McKean Pettit; great-granddaughter of Col. Charles Pettit and of Commodore Richard Dale, of Revolutionary memory, and of Chief Justice and Governor Thomas McKean, signer. He left one daughter, Mrs. John T. Gibson, of New York.

His domestic virtues were as beautiful, steadfast and altruistic as his professional life was admirable, sincere and progressive. He passed away in full belief of that higher existence in which there is "activity for all our powers, and power for all our activities."

March 23, 1903. HENRY PETTIT.

EXTRACT FROM THE PRESIDENT'S ADDRESS.

BY EDGAR F. SMITH.

(Read December 18, 1903.)

Amid the activities of the year, while we all have been busy in our several vocations, word has been passed from time to time that the grim Messenger had appeared in our circle and summoned to the silent majority not a few of our fellow-members. This roll included—

DR. CHARLES SCHAFFER, who was born in this city sixty-six years ago. He graduated from the Medical Department of the University of Pennsylvania at the age of twenty-one. His poor health prevented him from devoting himself wholly to his chosen profession. He was deeply interested in the natural sciences and their applications. He took an active part in the affairs of the Academy of Natural Sciences, the Historical Society of Pennsylvania, the Franklin Institute, the Photographic Society of Philadelphia, the American Association of Mining Engineers, and was particularly well known in the scientific world for his work in the field of botany. His knowledge of the local species of plants and shrubs was profound. He made a special study of the mountain flora of British Columbia. He died November 23, 1903.

DR. THOMAS G. MORTON was born in this city on August 8, 1835. After preparation in the city schools and the College of the University of Pennsylvania he entered the Medical Department, from which he graduated in 1856.

He devoted himself chiefly to general surgery and was a resident physician in the Pennsylvania Hospital for some time. He was one of the founders of the Polyclinic Hospital and the Orthopedic Hospital. His many services to the State on various boards and commissions included the erection of the State Hospital for the Insane for the Southern District of Pennsylvania.

In 1880 he was chosen President of the Pennsylvania Society for the Restriction of Vivisection and Vice-President of the Society to Protect Children from Cruelty. Dr. Morton had great success as a surgeon. His clinical lectures at the Pennsylvania Hospital were attended by thousands of students from all parts of the world. He was a member of various foreign and American professional bodies,

and a frequent contributor to journals of medicine. His own books are *The Transfusion of Blood* and *The Surgery of the Pennsylvania Hospital*, together with a history of the latter institution. He was actively engaged in public school work in this city, and for many years was a member of the Board's most important committees. He was a member of the Academy of Natural Sciences and of the Union League. He died May 20, 1903, at Cape May.

Rev. Henry Clay Trumbull was born in Connecticut, June 8, 1830. He received his education in Williston Seminary.

In 1858 he became a missionary for the State Sunday School Association, which had its headquarters in Hartford. He was a chaplain in the Tenth Regiment in the Civil War. In 1863 he was taken prisoner before Fort Wagner and sent to the Charleston jail, later to Libbey Prison, where he was held for several months.

Five of his books treat of his army experiences. They were *Some Army Soldiers*, *The Knightly Soldier*, *A Biography of Major Henry Ward Camp*, *The Captured Scout of the Army of the James* and *War Memoirs of an Army Chaplain.*

At the end of the war he returned to Sunday School work. In 1866 he received the degree of M.A. from Yale, and in 1881 the degree of D.D. from Lafayette College, and the same degree from the University of New York in 1882. In 1875 he took charge of the *Sunday School Times* of this city, and during his editorial career wrote a number of books of a devotional character. He traveled in Egypt, Arabia and Syria, where he studied the track of the Exodus and identified the site of Kadash-Barnia. Following this sojourn abroad he prepared a number of volumes, some of which bear these titles, *The Ten Commandments as a Covenant of Love*, *Light on the Story of Jonah*, *Subjects in Oriental Social Life*, *The Threshold Covenant*, *The Covenant of Saul*, etc., etc. He died in this city on December 8th.

Prof. Robert H. Thurston was born in Providence, R. I. In 1859 he graduated from Brown University with the degree of Civil Engineer. He served throughout the Civil War, beginning in 1861, being finally promoted to the position of chief engineer of one of the monitors. For six years he was an instructor in the United States Naval Academy at Annapolis. In 1871 he became Professor of Mechanical Engineering in the Stevens Institute of Technology.

This position he held until 1885, when he was called to the directorship of the Sibley College of Mechanic Arts at Cornell University. His work in both of these institutions of learning was most successful. It was characterized by great energy and executive ability. In 1873 Dr. Thurston was United States Commissioner to the Vienna Exposition. In 1875 he was appointed a member of the United States Board to Test Metals. In connection with this work he devised a machine for torsional tests, and made numerous investigations in the Mechanics of Materials.

In 1883 he published a work in three volumes, bearing the title *The Materials of Engineering*. Other books by him, such as the *Handbook of Engines and Boiler Trials, Stationary Steam Engines and Boiler Explosions*, have had a wide circulation. His *Manual of the Steam Engine*, in three volumes, was translated into French. Some of his other publications are *Friction and Lubrication, Friction and Lost Work, The Animal as a Machine and Prime Motor*, and *The Life of Robert Fulton.*

His contributions to scientific and engineering periodicals ran up into the hundreds.

He was a member of many scientific societies at home and abroad. He was one of the founders of the American Society of Mechanical Engineers, and its first President. He was a Vice-President of the American Association for the Advancement of Science in 1877, 1878 and in 1884.

The scientific and engineering work of Professor Thurston was of great benefit to mankind, for he made engineers better scientists, promoted engineering education, helped to put engineering upon a higher plane, and was constantly watching to dispel the fogs of prejudice by help of the truths of science.

He was the recipient of the honorary degree of LL.D. from his alma mater, and of the degree of Doctor of Engineering from Stevens Institute.

"In all his relations to general University problems he exhibited the spirit of the scholar and the wisdom of the man of affairs. Serene in temper, sound in judgment, swift and certain in action, he justly exercised a weighty influence.

"As a colleague he exhibited an interest in all good learning and bespoke a good scholar and a general fellow-worker. As a friend and companion, he manifested a cordial sympathy that attracted all who knew him and held them in the bonds of an increasing affec-

tion. In all the relations of life he moved upon the highest levels and showed forth the better qualities of our nature."

His loss falls heavily upon all—his colleagues, his friends and his University—but most heavily upon his family, with whom we deeply sympathize.

WILLIAM VINCENT MCKEAN was born in Philadelphia, October 15, 1820, and died March 23, 1903. He was associate editor of the *Pennsylvania* with John W. Forney in 1852; chief clerk of the House of Representatives from 1853 to 1855; examiner of the United States Patent Office; private secretary to James Buchanan; an editorial writer for the *Philadelphia Inquirer* and *Public Ledger*. He edited the *National Almanac Record* for 1864, and wrote a report favoring the money order system for the United States in 1858, *What the Navy Has Done During the War* in 1864, *General McClellan's Campaign* in 1864, and delivered an address in Independence Hall on July 2, 1876, entitled "The Centennial of American Independence."

THEODORE D. RAND was born in Philadelphia, September 16, 1836, and graduated from the Episcopal Academy and the Polytechnic College. In 1858 he was admitted to the Bar and practiced Law for a time. He was chiefly known for his scientific work in connection with Mineralogy and Geology, having published a number of papers on these branches and lectured very frequently before scientific bodies. He was a member of the Mineralogical section of the Academy of Natural Sciences, also the Franklin Institute and the American Institute of Mining Engineers. He died on April 24, aged sixty-seven years.

EDWARD RHOADS. It was only last spring that this young scientist was received into our membership. No one at that time dreamed that he would not be with us now in the full vigor of manhood. His history is briefly as follows:

Dr. Rhoads graduated with honors from Haverford College in 1893. He studied from 1896–1898 at Johns Hopkins University, from which institution he received the degree of Doctor of Philosophy. Immediately thereafter he became instructor in physics in the Worcester Polytechnic Institute. Leaving here in 1901 he was

appointed to a similar position in Haverford College. Among his publications we find the following titles:

"The Effect of the Fibrous Structure of Sheet Iron on the Changes in Length Accompanying Magnetizations."

"Experiments on the Change in Dimensions Caused by Magnetization in Iron."

"Relations Between the Changes in Thermo-Electric Power Caused in Magnetization."

Dr. Rhoads was unmarried and resided with his mother in Germantown. He was a member of the American Association for the Advancement of Science.

CHARLES GODFREY LELAND was born in Philadelphia in 1824, and received his education at Princeton and the Universities of Heidelberg, Munich and Paris. He was very active in the Revolution of 1848 and was one of the American delegates to congratulate the Provisional Government.

He studied and practiced Law in Philadelphia for four years, beginning with 1849, and then devoted himself to Journalism and the writing of books. In 1869 he removed to Europe, living chiefly in London, and was occupied with literature. On his return to America in 1880 he devoted much time in introducing the minor arts as a branch of instruction in public schools. Since 1886 he has been residing in Florence. He has been a frequent contributor to the Oriental, Social Science and Folklore Societies.

He published *Poetry and Mystery of Dreams* in 1850, *Hans Breitman's Ballads* in 1858, *English Gypsies* in 1852, *English Gypsy Ballads* in 1873, *Life of Abraham Lincoln* in 1881, *The Minor Arts* in 1881, *Gypsy Sorcery* in 1891, *Etruscan Roman Forms* in 1892, and numerous other books. His specialty seems to have been the study of tradition and folklore. He passed away on March 20, 1903, in Florence, Italy.

JAMES GLAISHER, F.R.S., an honored foreign member, attained the grand age of ninety-four years. When but twenty years old he was made an assistant on the principal triangulation of the Ordnance Survey of Ireland. His chief work during his life was the investigation of subjects on practical Meteorology. His contributions in this field and in Astronomy are exceedingly numerous and valuable. His hygrometrical tables, first published in 1847, passed through

eight editions, and with his *Travels in the Air*, *Diurnal Range Tables*, *Report on the Meteorology of India* and *Meteorology of Palestine*, are among his chief writings. In the interests of meteorology he made twenty-nine balloon ascensions in four years. In the one of September 5, 1862, he and his companion attained the highest distance from the earth (37,000 feet) ever reached. He was a pioneer in the systematic organization of meteorological observations. In 1850 he was one of the founders of the Royal Meteorological Society, being its original Secretary, "who nursed it through its infancy and youth, and left it to other hands only when it was old enough and strong enough to walk alone." He passed away February 7, 1903.

PROF. WILLIAM HARKNESS was born in Scotland on December 17, 1839. He died at Jersey City, N. J., U. S. A., February 28, 1903.

From *Science* we learn that he graduated in 1858 as an A.B. from Syracuse University, from which institution he also received the degrees of A.M. (1861) and LL.D. (1874). In 1862 he received the degree of M.D. from a New York school, and in August of that year became aid to the U. S. Naval Observatory. In August, 1863, he was commissioned Professor of Mathematics in the Navy with the rank of lieutenant-commander. From October, 1865, to June, 1866, he served on the U. S. Monitor Monadnock, making observations on the behavior of her compasses under the influence of the heavy iron armor of the ship. This was the most elaborate discussion of the behavior of compasses on armed ships that has ever been made. His report was published by the Smithsonian Institution in a volume of 225 quarto pages. On his return to Washington he was attached to the Hydrographic Office for one year, and thereafter for seven years to the Naval Observatory, during which period he observed the total solar eclipse at Des Moines, Iowa, and discovered the famous coronal line *K* 1474, also the total solar eclipse of December 22, 1870, at Syracuse, Sicily, and in 1871 was appointed one of the original members of the U. S. Transit of Venus Commission to arrange for the observation of the transits of that planet in 1874 and in 1882. He devised most of the instruments for the purpose and fitted out the various expeditions in this country. His own station was at Hobart, Tasmania.

In 1875 he studied the observations of the U. S. parties from a series of wet collodion photographs on glass plates. He suc-

ceeded where others failed, and in the course of his study in 1877 invented the spherometer caliper. In 1879 he discovered the theory of the focal curve of achromatic telescopes. In 1876 he set up the Government astronomical exhibit at the Centennial Exposition in Philadelphia, Pa. In 1878 he observed the transit of Mercury at Austin, Texas, and the total solar eclipse at Creston, Wyoming, in July of that year, 1878. He carried on extensive experiments in astronomical photography, and in 1881 to 1883 was engaged in reducing the zones of stars observed by Capt. Gillin at Santiago, Chile, in 1849 to 1852. In 1888–9 and 1890 he gave much time to the preparation of his work on *The Solar Parallax and Its Related Constants*. From 1891-1899 he was chiefly occupied in following the erection of the new Naval Observatory, in devising and mounting its instruments, etc., etc. In 1894 he became astronomical director of the Naval Observatory, with complete control of all its astronomical work. He also became director of the *Nautical Almanac* in June, 1897. These offices he held until his retirement for age, December 17, 1899, with the rank of rear-admiral. He was the author of many scientific papers and member of numerous scientific societies, President of the Washington Philosophical Society in 1887, and President of the American Association for the Advancement of Science in 1893.

Prof. J. Peter Lesley. There are those in this audience who can speak more fully of this departed friend than the speaker. These halls knew the great geologist well. The interests of this Society were his. Many hours did he bestow upon its affairs, and about us there are many evidences of his unselfish labors. My knowledge of him was very slight. I saw him frequently in the halls and the museum of the University of Pennsylvania, but beyond the formal bow it was not my privilege to know him. In the September issue of the *American Geologist* for 1903 our associate, Dr. Persifor Frazer, has recorded a picture of this successful teacher and investigator, from which we abstract the following facts. This city was Lesley's birthplace. The natal day was September 17, 1819. His training was received here and in the University, where he completed his studies in 1838. At Princeton he studied Theology from 1841 to 1843, and in 1844 obtained his ministerial license. The year of 1844-45 he spent in study at the University of Heidelberg. For five years (1846-1851) he officiated as pastor of the

Congregational Church in Milton, Mass. At the expiration of that period he left the ministry and devoted his whole time to geological pursuits. In 1872 he became Professor of Geology and Mining in the University of Pennsylvania, as well as the Dean of its Faculty of Science. In 1874 he was entrusted with the directorship of the second geological survey of this State.

"The hundred volumes and thousands of maps and sections of this survey will be his most enduring monument."

He threw great light upon the rock oil problem. He was one of the original members of the National Academy of Sciences; President of the American Association for the Advancement of Science in 1884, and author of *Man, His Origin and Destiny, from the Platform of the Sciences; Coal and Its Topography, etc.*

"Lesley's character was wholly noble. He was generous to prodigality towards others while careless of his own ease and comfort. Plain living and high thinking was the motto which moulded his life."

Surrounded in his closing years by a loving wife and devoted daughters, he peacefully passed away on June 1, 1903, at Milton, Mass.

Sir George Gabriel Stokes was born August 13, 1819, at Skreen, County Sligo, of which parish his father was rector. He entered Pembroke College, Cambridge, in 1837, graduated in 1841, became Fellow of the College in the same year, and in 1849 was elected Lucasian Professor of Mathematics.

Professor Tate writes, "To us, who were mere undergraduates when he was elected to the Lucasian Professorship, but who had with mysterious awe speculated on the relative merits of the man of European fame whom we expected to find competing for so high an honor, the election of a young and (to *us*) an unknown candidate was a very startling phenomenon, but we were still more startled a few months afterwards when the new Professor gave public notice that he considered it part of the duties of his office to assist any member of the University in difficulties he might encounter in his mathematical subjects. Here was, we thought, a single knight fighting against the whole melee of the tournament, but we soon discovered our mistake, and felt that the undertaking was the effect of an earnest sense of duty on the conscience of a singularly modest but exceptionally able and learned man, and so it has

proved." Stokes may justly be looked upon as in a sense one of the intellectual parents of the school of Natural Philosophy which Cambridge has nurtured, the school which numbers in its ranks Sir William Thompson and Sir William Maxwell.

He was really a great discoverer in Mathematics and Physics. Stokes fully apprehended the physical basis of spectral analysis and pointed out how it could be applied to the detection of the constituents of the atmosphere of the sun and stars. In some of his earlier papers he has laid down the scientific distinction between rotational and differentially irrotational motion, which forms the basis of Helmholtz's magnificent investigations about vortex motion. His papers on the (long) spectrum of the electric light, and particularly those on the absorbent spectrum of the blood, are of very great value.

Sir William Thompson says that Stokes roamed over the whole domain of Natural Philosophy in his work and thought, Electricity being the single field which he looked upon from the outside. He even enriched pure Mathematics of a highly transcendental kind. Mathematics with Stokes was the servant and assistant, not the master. In science his guiding star was Natural Philosophy. In 1843 he published his *Theory of the Viscosity of Fluids* and a little later his *Theory of Oscillatory Waves*. "The Dynamical Theory of Diffraction" was one of his most important contributions on the subject of light. In his paper on "The Change of Refrangibility of Light" he described his now well-known discovery of Fluorescence, according to which a fluorescent substance emits in all directions from the course through it of a beam of homogeneous light.

Stokes' scientific work and scientific thought are but partially represented by his public writings. He gave generously and freely of his treasures to all who were fortunate enough to have the opportunity of receiving from him.

Sir William Thompson says "that his teaching me the principles of solar and stellar Astronomy while we were walking about among the Colleges, sometime prior to 1852, is but one example of his generosity."

The funeral of this great man took place last February at Cambridge, England. The most distinguished representatives of many branches of learning were present. The University church was crowded in every part. The assembly constituted a living witness

of the esteem in which the memory of Sir George Stokes is held in the intellectual world. The coffin containing the late Master's body was first carried around the court of Pembroke College, in accordance with an ancient custom reserved for Masters, the procession being formed of the choir and officiating clergy, the Fellows of the College, former Fellows, Masters of Arts, Bachelors of Arts and undergraduates. The interment took place at Mill Road Cemetery.

In the words of Lord Kelvin, "The world is poorer through his death, and we who knew him feel the sorrow of bereavement."

PROF. JOSIAH WILLARD GIBBS. From the *American Journal of Science* for September, 1903, we glean that he was born February 11, 1839, in New Haven, where his father was professor of Sacred Literature in the Yale Divinity School. He entered Yale College in 1854 and graduated in 1858. During his academic course he received several prizes in Latin and Mathematics. In 1863 he won the Ph.D. degree and was appointed to a tutorship in the College. The winter of 1866-67 he spent in Paris, and the year following went to Berlin, where he heard Magnus and others in physics and mathematics. In 1868 he listened to Kirchhoff and Helmholtz at Heidelberg. In 1871 he became Professor of Mathematical Physics at Yale; this position he held until the time of his death. It was not until he was thirty-four years old that he gave to the world, by publication, evidence of his extraordinary powers as an investigator in Mathematical Physics. In 1876 and 1878 appeared two parts of his great paper "On the Equilibrium of Heterogeneous Substances." The third overshadowed these somewhat. This is his most important contribution to physical science. It is one of the greatest and most enduring monuments of the wonderful scientific activity of the nineteenth century.

The publication of this work was universally regarded an event of the first importance in the history of Chemistry. It founded a new department of chemical science. Yet years elapsed before its value was generally recognized. It was translated into German in 1891 by Ostwald, and into French in 1899 by LeChatelier.

In 1881 and 1884 he printed for private use a concise account of vector analysis. This he applied to some of the problems of astronomy. In 1888 to 1889 he contributed five papers on points in the electro-magnetic theory of light and its relations to the various elas-

tic theories. His last work was upon *Elementary Principles in Statistical Mechanics.*

The value of Williard Gibbs' work to science has been formally recognized by many learned societies and universities at home and abroad. He was a member of the National Academy of Sciences, the Royal Institute of Great Britain, the Royal Society of London, etc., etc., and the recipient of honorary degrees from Williams College and from the Universities of Erlangen, Princeton and Christiana. In 1881 he received the Rumford medal from the American Academy of Boston, and in 1901 the Copley medal of the Royal Society of London.

His life was uneventful. He made but one visit to Europe. He lived in New Haven, in the same home which his father built, a few rods from the school where he prepared for College and from the University, in the service of which his life was spent. He never married. He was retiring in disposition, went little into society and was known to few outside the University. His modesty in regard to his work was proverbial. "Unassuming in manner, genial and kindly in his intercourse with his fellow-men, devoid of personal ambition of the baser sort, or of the slightest desire to exalt himself, he went far toward realizing the ideal of the unselfish Christian gentleman." He died April 28, 1903.

They are gone. The world and we shall miss them. May the good they have accomplished serve as further incentives to us to press forward—each in his own specialty—without ceasing, in quest of the all-satisfying, all-enlightening truth.

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LIST OF MEMBERS

OF THE

American Philosophical Society

HELD AT PHILADELPHIA

FOR PROMOTING USEFUL KNOWLEDGE

(Founded 1743)

January, 1904.

LIST OF MEMBERS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

JANUARY, 1904.

A

	Name.	*Date of Election.*	*Present Address.*
1687.	ABBE, CLEVELAND, Prof.	July 27, 1871,	U. S. Weather Bureau, Washington, D. C.
1463.	ABBOT, HENRY L., Gen. U.S.A. .	April 18, 1862,	23 Berkeley St., Cambridge, Mass.
2311.	ABBOTT, ALEXANDER C., M.D. . .	Feb'y 19, 1897,	University of Pennsylvania, Philadelphia.
2170.	ABBOTT, CHARLES CONRAD, M.D..	Dec. 20, 1889,	Trenton, N. J.
1809.	ÅCKERMAN, RICHARD, Prof. . . .	July 21, 1876,	Stockholm, Sweden.
2128.	ADAM, LUCIEN.	Dec. 17, 1886,	41 Bard Sevigné, Rennes, France.
2457.	ADAMS, CHARLES FRANCIS, LL.D.	Feb. 15, 1901,	23 Court St., Boston.
2451.	ADLER, CYRUS, Ph.D.	May 18, 1900,	Smithsonian Institution, Washington, D. C.
1779.	AGASSIZ, ALEXANDER, Prof. . . .	April 16, 1875,	Cambridge, Mass.
1642.	AGASSIZ, MRS. ELIZABETH	Oct. 15, 1869,	Quincy St., Cambridge, Mass.
2380.	ALLEN, ALFRED H., F.C.S. . . .	May 20, 1898,	67 Surrey St., Sheffield, Eng.
1869.	ALLEN, JOEL ASAPH, Prof. . . .	Sept. 20, 1878,	Am. Museum of Natural History, New York.
1927.	AMES, REV. CHARLES G.	Jan'y 21, 1881,	12 Chestnut St., Boston, Mass.
2064.	ANDERSON, GEO. L., Maj. U.S.A.	Feb'y 19, 1886,	Ordnance Board, Governor's Island, New York City.
2164.	ANGELL, JAMES B., LL.D., Pres't..	Oct. 18, 1889,	Ann Arbor, Mich.
2220.	APPLETON, WILLIAM HYDE, Prof.	May 19, 1893,	Swarthmore, Pa.
2012.	ASHHURST, RICHARD L.	April 18, 1884,	319 S. 11th St., Philadelphia.
2019.	AVEBURY, The Right Hon. Lord.	July 18, 1884,	High Elms, Down, Kent, Eng.

B

1995.	BACHE, R. MEADE.	Jan'y 18, 1884,	4400 Sansom St., Philadelphia.
1832.	BACHE, THOMAS HEWSON, M.D .	Feb'y 2, 1877,	233 S. 13th St., Philadelphia.
2389.	BAER, GEORGE F.	Dec. 16, 1898,	1718 Spruce St., Philadelphia.
2285.	BAILEY, L. H., Prof.	May 15, 1896,	Cornell University, Ithaca, N.Y.
1630.	BAIRD, HENRY CAREY	Jan'y 15, 1869,	810 Walnut St., Philadelphia.
1991.	BAIRD, HENRY M., Prof.	Jan'y 18, 1884,	219 Palisade Ave., Yonkers, N.Y.
2419.	BALCH, EDWIN SWIFT.	Dec. 15, 1899,	1412 Spruce St., Philadelphia.
2467.	BALCH, THOMAS WILLING	May 17, 1901,	1412 Spruce St., Philadelphia.
2345.	BALDWIN, JAMES MARK, Prof. . .	Oct. 15, 1897,	Princeton, N. J.
2191.	BALL, SIR ROBERT STAWELL . .	May 15, 1891,	Observatory, Cambridge, Eng.
1965.	DEBAR, HON. EDOUARD SÈVE . .	July 21, 1882,	Ramsgate, England.
1741.	BARKER, GEORGE F., LL.D., Prof..	April 18, 1873,	3909 Locust St., Philadelphia.
2011.	BARKER, WHARTON	April 18, 1884,	119 S. 4th St., Philadelphia.
2489.	BARNARD, EDWARD E., Sc.D . .	April 3, 1903,	Yerkes Observatory, Williams Bay, Wisconsin.

	Name.	*Date of Election.*	*Present Address.*
1902.	BARTHOLOW, ROBERTS, M.D. . .	April 16, 1880,	1525 Locust St., Philadelphia.
2490.	BARUS, CARL, Ph.D., Prof. . . .	April 3, 1903,	30 Elm Grove Ave., Providence, Rhode Island.
2119.	BASTIAN, ADOLPH, Prof.	Dec. 17, 1886,	Königgrätzerstrasse 120, Berlin, Germany.
2421.	BAUGH, DANIEL	Dec. 15, 1899,	1601 Locust St., Philadelphia.
2482.	BECQUEREL, ANTOINE-HENRI, Prof.	April 4, 1902,	6me d'Urville, Paris, France.
1968.	BELL, ALEXANDER GRAHAM, Prof.	July 21, 1882,	1331 Connecticut Ave., Washington, D. C.
1802.	BELL, SIR LOWTHIAN, Bart. . . .	April 21, 1876,	Northallerton, England.
2255.	BEMENT, CLARENCE S.	May 17, 1895,	3907 Spruce St., Philadelphia.
2326.	DEBENNEVILLE, JAMES S	Oct. 15, 1897,	University Club, Philadelphia.
2264.	BERTHELOT, MARCELIN P. E., D. ès-Sc.	May 17, 1895,	Palais de l'Institut de France, Rue Mazarin, No. 3, VIe., Paris, France.
2253.	BERTIN, GEORGES	May 17, 1895,	11 bis Rue Ballu, Paris.
1920.	BIDDLE, CADWALADER	Oct. 15, 1880,	1420 Walnut St., Philadelphia.
1831.	BIDDLE, HON. CRAIG	Feb'y 2, 1877,	2033 Pine Street, Philadelphia.
2134.	BILLINGS, JOHN S., M.D.	Feb'y 18, 1887,	40 Lafayette Place, New York.
2256.	BISPHAM, GEORGE TUCKER . . .	May 17, 1895,	1805 DeLancey Place, Phila.
2157.	BLAIR, ANDREW A.	May 17, 1889,	406 Locust Street, Philadelphia.
1669.	BLAKE, WM. PHIPPS, Prof. . . .	Oct. 21, 1870,	Tucson, Arizona.
2491.	BOAS, FRANZ, Ph.D.	April 3, 1903,	Am. Museum of Nat. History, Central Park, New York.
1444.	VON BÖHTLINGK, M. OTTO, . . .	Jan'y 17, 1862,	Seeburgstrasse 35, II, Leipzig, Germany.
2235.	BONAPARTE, PRINCE ROLAND . .	Feb'y 15, 1895,	10 Ave. d'Jena 22, Paris, France.
1126.	BOYÉ, MARTIN H., Prof. . . .	Jan'y 17, 1840,	Coopersburg, Lehigh Co., Pa.
1826.	BRACKETT, CYRUS FOGG, Prof. . .	Feb'y 2, 1877,	Princeton, N. J.
2083.	BRANNER, JOHN C., Prof. . . .	May 21, 1886,	Stanford University, Cal.
2476.	BRASHEAR, JOHN A., Sc.D. . . .	April 4, 1902,	1954 Perryville Ave., Allegheny, Pa.
2095.	BREZINA, ARISTIDES, Dr.	May 21, 1886,	XIIIe St. Veitgasse, 15. Vienna, Austria.
2069.	BRINTON, JOHN H., M.D	Feb'y 19, 1886,	1423 Spruce St., Philadelphia.
2433.	BROCK, ROBERT C. H.	Dec. 15, 1899,	1612 Walnut St., Philadelphia.
2445.	BROEGGER, W. C., Prof.	Dec. 15. 1899,	Christiania, Norway.
2080.	BROOKS, WILLIAM KEITH, Prof. .	May 21, 1886,	Johns Hopkins Univ., Baltimore, Maryland.
2466.	BROWN, AMOS P., Prof.	May 17, 1901,	20 E. Penn St., Germantown, Philadelphia.
1881.	BROWN, ARTHUR ERWIN	April 18, 1879,	1208 Locust St., Philadelphia.
2394.	BROWN, ERNEST WILLIAM, Prof.	Dec. 16, 1898,	Haverford College, Pa.
2275.	BRUBAKER, ALBERT P., M.D. . .	Oct. 18, 1895,	105 N. 34th St., Philadelphia.
1547.	BRUSH, GEORGE J., Prof.	Jan'y 20, 1865,	Yale Univ., New Haven, Conn.
2376.	BRYANT, HENRY GRIER, F.R.G.S.	May 20, 1898,	Room 805 Land Title Building, Philadelphia.
2237.	BRYCE, RIGHT HON. JAMES . . .	Feb'y 15, 1895,	54 Portland Place, London, W., England.
2236.	BUDGE, E. A. WALLIS, Litt.D . .	Feb'y 15, 1895,	British Museum, London, Eng.
2007.	BURK, REV. JESSE Y	Jan'y 18, 1884,	400 Chestnut St., Philadelphia.
1938.	BUTLER, HON. WILLIAM	April 15, 1881,	West Chester, Pa.
	C		
2416.	CADWALADER, JOHN	May 19, 1899,	1519 Locust St , Philadelphia.
1788.	CAMPBELL, JOHN LYLE, Ph.D., Prof.	July 16, 1875,	Crawfordsville, Ind.

	Name.	*Date of Election.*	*Present Address.*
2492.	CAMPBELL, WM. W., Sc.D., LL.D.	April 3, 1903,	Lick Observatory, Mt. Hamilton, California.
1606.	CANBY, WILLIAM MARRIOTT . . .	Oct. 16, 1868,	1101 Delaware Avenue, Wilmington, Del.
2051.	CANNIZZARO, TOMASO	Oct. 16, 1885,	Santa Maria fuori cinta, Casa Roffia, Messina, Sicily.
1731.	CAPELLINI, GIOVANNI, Prof. . .	April 18, 1873,	Portovenere près Spezia, Italy.
1796.	CARLL, JOHN F., Prof.	Oct. 15, 1875,	Pleasantville, Venango Co., Pa.
2469.	CARNEGIE, ANDREW, LL.D . . .	April 4, 1902,	2 East 91st St., New York.
1911.	CARSON, HAMPTON L., LL.D. . .	April 16, 1880,	1033 Spruce St., Philadelphia.
2260.	CARTER, HON. JAMES C	May 17, 1895,	54 Wall Street, New York City.
1707.	CASSATT, ALEXANDER J	Oct. 18, 1872,	Haverford, Delaware Co., Pa.
2147.	CASTNER, SAMUEL, JR.	Dec. 16, 1887,	3729 Chestnut St., Philadelphia.
2152.	CATTELL, J. MCKEEN, Prof. . . .	May 18, 1888,	Garrison-on-Hudson, N. Y.
1908.	CHANCE, HENRY MARTYN, M.D .	April 16, 1880,	819 Drexel Building, Phila.
1783.	CHANDLER, C. F , Prof.	April 16, 1875,	Columbia Univ., N. Y. City.
1778.	CHAPMAN, HENRY C., M.D. . . .	April 16, 1875,	2047 Walnut St., Philadelphia.
2132.	DE CHARENCEY, COMTE HYACINTH	Dec. 17, 1886,	25 Rue Barbet de Jouy, Paris, France.
2158.	CLARK, CLARENCE H.	May 17, 1889,	42d and Locust Sts., Phila.
2470.	CLARK, WILLIAM BULLOCK, Prof.	April 4, 1902,	Johns Hopkins University, Baltimore, Md.
1983.	CLAYPOLE, E. W., Prof.	Jan'y 19, 1883,	Pasadena, Cal.
2247.	CLEEMANN, RICHARD A., M.D . .	Feb'y 15, 1895,	2135 Spruce St., Philadelphia.
2336.	CLEVELAND, HON. GROVER . . .	Oct. 15, 1897,	Westland, Princeton, N. J.
1999.	COHEN, J. SOLIS, M.D.	Jan'y 18, 1884,	1824 Chestnut St., Philadelphia.
2429.	COLES, EDWARD	Dec. 15, 1899,	2010 DeLancey Place, Phila.
2475.	COLLITZ, HERMAN, LL.D., Prof .	April 4, 1902,	Bryn Mawr, Pa.
2305.	CONKLIN, EDWIN GRANT, Prof. .	Feb'y 19, 1897,	University of Penna., Phila.
2386.	CONVERSE, JOHN H.	May 20, 1898,	500 N. Broad St., Philadelphia.
2257.	COOK, JOEL	May 17, 1895,	849 N. Broad St., Philadelphia.
2129.	CORA, GUIDO, Prof.	Dec. 17, 1886,	2 Via Goito, Rome, Italy.
2205.	CRAMP, CHARLES H	Dec. 16, 1892,	507 S. Broad St., Philadelphia.
1836.	CRANE, THOMAS FREDERICK, Prof.	Feb'y 2, 1877,	Cornell Univ., Ithaca, N. Y.
2100.	CROOKES, SIR WILLIAM	May 21, 1886,	7 Kensington Park Gardens, London, W., England.
2391.	CROWELL, EDWARD P., Prof. . .	Dec. 16, 1898,	21 Amity St., Amherst, Mass.
2317.	CULIN, STEWART	May 21, 1897,	Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y.

D

2361.	DALL, WILLIAM H., Prof. . . .	Dec. 17, 1897,	U. S. National Museum, Washington, D. C.
2402	DANA, CHARLES E.	May 19, 1899,	2013 DeLancey Place, Philadelphia.
2282.	DANA, EDWARD S., Prof. . . .	May 15, 1896,	Yale Univ., New Haven, Conn.
1806.	DANNEFELD, C. JUHLIN	April 21, 1876,	Stockholm, Sweden.
2480.	DARBOUX, JEAN-GASTON	April 4, 1902,	36 Rue Gay-Lussac, Paris, France
2369.	DARWIN, GEORGE HOWARD, Prof.	Feb'y 18, 1898,	Newham Grange, Cambridge, England.
1811.	DAVENPORT, SIR SAMUEL	Oct. 20, 1876,	Beaumont, Adelaide, S. Australia.
1557.	DAVIDSON, GEORGE, Prof.	Jan'y 19, 1866,	2221 Washington St., San Francisco, Cal.
2417.	DAVIS, WILLIAM MORRIS, Prof. .	Oct. 20, 1899,	Cambridge, Mass.
1923.	DAWKINS, WILLIAM BOYD, Prof.	Oct. 15, 1880,	Woodhurst, Fallowfield, Manchester, England.

	Name.	*Date of Election.*	*Present Address.*
2418.	DAY, FRANK MILES	Oct. 20, 1899,	801 Penn Mutual Building, Philadelphia.
2406.	DAY, WILLIAM C., Prof.	May 19, 1899,	Swarthmore, Pa.
2360.	DE GARMO, CHARLES, Prof. . . .	Dec. 17, 1897,	Cornell Univ., Ithaca, N. Y.
2208.	DERCUM, FRANCIS X., M.D. . . .	Dec. 16, 1892,	1719 Walnut St., Philadelphia.
2434.	DEWAR, JAMES, LL.D., Prof. . . .	Dec. 15, 1899,	The Royal Institution, London, England.
2013.	DICKSON, SAMUEL	April 18, 1884,	901 Clinton St., Philadelphia.
2206.	DIXON, SAMUEL G., M.D	Dec. 16, 1892,	Black Rock Farm, Ardmore, Pa.
2504.	DOHRN, ANTON, Dr.	April 3, 1903,	Marine Zoological Station, Naples, Italy.
2108.	DOLLEY, CHARLES S., M.D. . . .	Dec. 17, 1886,	3707 Woodland Ave., Phila.
2089.	DONNER, OTTO, Prof.	May 21, 1886,	Helsingfors, Finland.
1946.	DOOLITTLE, C. L., Prof.	Oct. 21, 1881,	Upper Darby, Delaware Co., Pa.
2493.	DOOLITTLE, ERIC	April 3, 1903,	University of Pennsylvania, Philadelphia.
2425.	DOUGHERTY, THOMAS HARVEY .	Dec. 15, 1899,	School House Lane, Germantown, Philadelphia.
1839.	DOUGLAS, JAMES, LL D.	April 20, 1877,	Spuytenduyvil, NewYork, N.Y.
1924.	DRAPER, DANIEL, Ph.D	Oct. 15, 1880,	Meteorological Observatory, Central Park, New York.
1787.	DROWN, THOMAS M., Pres't . . .	July 16, 1875,	Lehigh Univ., S. Bethlehem, Pa.
1918.	DU BOIS, PATTERSON	Oct. 15, 1880,	401 S. 40th St., Philadelphia.
1878.	DUDLEY, CHARLES BENJ., Ph.D. .	Jan'y 17, 1879,	Drawer 334, Altoona, Blair Co., Pa.
2063.	DUNCAN, LOUIS, Ph.D., U.S.N. . .	Feb'y 19, 1886,	Mass. Institute of Technology, Boston.
1573.	DUNNING, GEORGE F.	Jan'y 18, 1867,	Farmington, Conn.
1727.	DUPONT, EDOUARD	April 18, 1873,	Royal Museum, Bruxelles, Belgium.
2227.	DUPONT, HENRY A., Col.	Feb'y 16, 1894,	Winterthur, Del.
1679.	DUTTON, CLARENCE E., Maj. U.S.A.	Jan'y 20, 1871,	Morgan Park, Cook Co., Ill.
	E		
2105.	EASTON, MORTON W., Prof. . . .	Dec. 17, 1886,	224 S. 43d St., Philadelphia.
1917.	ECKFELDT, JACOB B	Oct. 15, 1880,	U. S. Mint, Philadelphia.
1825.	EDDY, H. TURNER, Prof	Feb'y 2, 1877,	University of Minnesota, Minneapolis, Minn.
2294.	EDISON, THOMAS A., Ph.D	May 15, 1896,	Orange, N. J.
2262.	EDMUNDS, HON. GEORGE F. . . .	May 17, 1895,	1724 Spruce St., Philadelphia.
1686.	ELIOT, CHARLES W., Pres't	April 21, 1871,	17 Quincy St., Cambridge, Mass.
2272.	ELLIOTT, A. MARSHALL, Prof. . .	May 17, 1895,	Johns Hopkins University, Baltimore, Md.
2313.	ELY, THEODORE N.	May 21, 1897,	115 Broad St. Station, Phila.
2356.	EMERSON, BENJ. KENDALL, Prof.	Dec. 17, 1897,	Amherst, Mass.
2368.	EMMET, W. L. R	Feb'y 18, 1898,	48 Washington Ave., Schenectady, N. Y.
1981.	EMMONS, S. F., Prof.	Jan'y 19, 1883,	1721 H St., Washington, D. C.
1943.	EVANS, SIR JOHN, K.C.B	Oct. 21, 1881,	Nash Mills, Hemel Hempstead, England.
2254.	EWELL, MARSHALL D, M.D., LL.D.	May 17, 1895,	59 Clark St., Chicago, Ill.
	F		
2234.	FENNELL, C. A. M., Litt.D. . . .	Feb'y 15, 1895,	139 Chesterton Road, Cambridge, England.
2180.	FIELD, ROBERT PATTERSON . . .	May 16, 1890,	218 S. 42d St., Philadelphia.
2364.	FINE, HENRY B, Prof	Dec. 17, 1897,	Princeton, N. J.

	Name.	*Date of Election.*	*Present Address.*
2353.	FISHER, SYDNEY GEORGE	Dec. 17, 1897,	328 Chestnut St., Philadelphia.
2462.	FLEXNER, SIMON, Dr.	Feb'y 15, 1901,	University of Pennsylvania, Philadelphia.
1901.	FLINT, AUSTIN, M.D.	April 16, 1880,	60 E. 34th St., New York, N.Y.
2197.	FORBES, GEORGE, Prof., F.R.S. .	Oct. 16, 1891,	34 GreatGeorge St.,S.W.London.
2487.	FOSTER, SIR MICHAEL, K.C.B., F.R.S., D.C.L	April 4, 1902,	Nine Wells, Great Shelford, Cambridge, Eng.
1912.	FRALEY, JOSEPH C.	April 16, 1880,	1833 Pine St., Philadelphia.
1695.	FRAZER, PERSIFOR, Dr. ès-Sc. Nat.	Jan'y 19, 1872,	928 Spruce St., Philadelphia.
2301.	FRAZIER, BENJ. W., Prof. . . .	Dec. 18, 1896,	Lehigh Univ., Bethlehem, Pa.
2171.	FRIEBIS, GEORGE, M.D.	Dec. 20, 1889,	1906 Chestnut St., Philadelphia.
2179.	FULLERTON, GEORGE S., Rev. . .	May 16, 1890,	89, The Gladstone, Philadelphia.
1739.	FULTON, JOHN	April 18, 1873,	136 Park Pl., Johnstown, Pa.
1914.	FURNESS, HORACE Howard, LL.D.	April 16, 1880,	Wallingford, Delaware Co., Pa.
2306.	FURNESS, HORACE HOWARD, JR..	Feb'y 19, 1897,	2034 DeLancey Place, Phila.
2304.	FURNESS, WILLIAM H., 3d, M.D. .	Feb'y 19, 1897,	1906 Sansom St., Philadelphia.
	G		
2459.	GARNETT, RICHARD, C.B., LL.D..	Feb'y 15, 1901,	27 Tanza Road, Hampstead, London, England.
1988.	GARRETT, PHILIP C	April 20, 1883,	Logan P. O., Philadelphia.
2079.	GATES, MERRILL E., LL.D	May 21, 1886,	1315 New Hampshire Ave., Washington, D. C.
1025.	GATSCHET, ALBERT S., Ph.D . . .	Oct. 17, 1884,	2020 Fifteenth St., N. W., Washington, D. C.
1897.	GEIKIE, SIR ARCHIBALD	Jan'y 16, 1880,	28 Jermyn St., London, S. W., England.
1803.	GEIKIE, JAMES, Prof.	April 21, 1876,	31 Merchiston Ave., Edinburgh, Scotland.
2067.	GENTH, F. A., JR	Feb'y 19, 1886,	103 N. Front St., Philadelphia
1355.	GIBBS, OLIVER WOLCOTT, Prof. .	July 21, 1854,	158 Gibbs Ave., Newport, R. I.
2458.	GIGLIOLI, HENRY H., Prof. .	Feb'y 15, 1901,	19 Via Romana, Florence, Italy.
2483.	GILBERT, GROVE K., LL.D. . . .	April 4, 1902,	U. S. Geological Survey, Washington, D. C.
2494.	GILDERSLEEVE, BASIL L., LL.D., Prof.	April 3, 1903,	1002 Belvidere Terrace, Baltimore, Md.
1587.	GILL, THEODORE N., M.D., Ph.D .	July 19, 1867,	Smithsonian Inst., Washington, D. C.
1800.	GILMAN, DANIEL C., LL.D	April 21, 1876,	614 Park Ave., Baltimore, Md.
2233.	GLAZEBROOK, RICHARD T., F.R.S.	Feb'y 15, 1895,	Bushey House, Teddington, Middlesex, Eng.
2212.	GOODALE, GEORGE LINCOLN, Prof	Feb. 17, 1893,	10 Craigie St., Cambridge, Mass.
2292.	GOODSPEED, ARTHUR W., Prof.	May 15, 1896,	Univ. of Pennsylvania, Philadelphia.
2203.	GOODWIN, HAROLD.	May 20, 1892,	133 S. 12th St., Philadelphia.
2232.	GOODWIN, W. W., Prof.	Feb'y 15, 1895,	Cambridge, Mass.
2453.	GRAY, GEORGE, Hon.	May 18, 1900,	Wilmington, Del.
2222.	GREEN, SAMUEL A., M.D.	Oct. 20, 1893,	Historical Soc., Boston, Mass.
1880.	GREENE, WILLIAM H., M.D. . . .	April 18, 1879,	N. E. Cor. Arch and 16th Sts., Philadelphia.
2412.	GREENMAN, MILTON J., M.D. . .	May 19, 1899,	Wistar Institute, 36th and Darby Road, Philadelphia.
2155.	DI GREGORIO, MARCHESE ANTONIO	Dec. 21, 1888,	Al Molo, Palermo, Sicily.

	Name.	*Date of Election.*	*Present Address.*
2188.	GREGORY, CASPAR RÉNÉ, Prof. . .	May 15, 1891,	Naunhofstrasse 25, Marienhöhe, Leipzig-Stotteritz, Germany.
2090.	DE GUBERNATIS, ANGELO, Prof. . .	May 21, 1886,	Florence, Italy.
2495.	GUMMERE, FRANCIS BARTON, Ph.D., Prof.	April 3, 1903,	Haverford College, Haverford, Pa.
	H		
2479.	HADLEY, ARTHUR T., Pres't. . .	April 4, 1902,	Yale University, New Haven, Conn.
2054.	HAECKEL, ERNST, Prof.	Oct. 16, 1885,	University, Jena, Germany.
2496.	HAGUE, ARNOLD, D.Sc.	April 3, 1903,	1724 I St., Washington, D. C.
1658.	HALE, REV. EDWARD EVERETT, .	Jan'y 21, 1870,	39 Highland St., Roxbury, Mass.
2477.	HALE, GEORGE E., Prof.	April 4, 1902,	Yerkes Observatory, Williams Bay, Wis.
1853.	HALL, ASAPH, Prof.	Jan'y 18, 1878,	South Norfolk, Conn.
1795.	HALL, CHARLES EDWARD.	Oct. 15, 1875,	Instituto Geologico de Mexico, Santa Maria, Mexico, Mexico.
2396.	HALL, CHARLES M.	Dec. 16, 1898,	Niagara Falls, N. Y.
2027.	HALL, LYMAN B., Prof.	Jan'y 16, 1885,	Haverford Coll., Haverford, Pa.
2194.	HAMY, E. T., Dr	May 15, 1891,	40 Rue Lübeck, Ave. du Trocadero, Paris, France.
2136.	HARRIS, JOSEPH S.	May 20, 1887,	144 School Lane, Germantown, Philadelphia.
2246.	HARRISON, CHARLES C., Provost.	Feb'y 15, 1895,	400 Chestnut St., Philadelphia.
1827.	HART, JAMES MORGAN, Prof. . .	Feb'y 2, 1877,	1 Reservoir Ave., Ithaca, N. Y.
2365.	HATCHER, JOHN B., Prof. . . .	Dec. 17, 1897,	Carnegie Museum, Pittsburgh, Pa.
1681.	HAUPT, HERMANN, Gen	April 21, 1871,	The Concord, Washington, D.C.
1862.	HAUPT, LEWIS M., Prof.	May 3, 1878,	107 N. 35th St., Philadelphia.
2481.	HAUPT, PAUL, Prof.	April 4, 1902,	2511 Madison Ave., Baltimore.
2446.	HAY, JOHN, Hon.	Dec. 16, 1898,	State Dep't, Washington, D.C.
2082.	HAYES, RICHARD SOMERS, Capt.	May 21, 1886,	32 Nassau St., New York.
2071.	HAYS, I. MINIS, M.D.	Feb'y 19, 1886,	266 S. 21st St., Philadelphia.
1985.	HEILPRIN, ANGELO, Prof	April 20, 1883,	1801 Arch St., Philadelphia.
2218.	HEWETT, WATERMAN T., Prof. .	May 19, 1893,	31 East Ave., Ithaca, N. Y.
2266.	HEYSE, PAUL, Ph.D.	May 17, 1895,	Munich, Bavaria.
2497.	HILL, GEORGE WILLIAM, LL.D. .	April 3, 1903,	West Nyack, N. Y.
2307.	HILLER, H. M., M.D.	Feb'y 19, 1897,	1510 Walnut St., Philadelphia.
2110.	HILPRECHT, HERMANN V., Prof.	Dec. 17, 1886,	403 S. 41st St., Philadelphia.
1768.	HIMES, CHARLES FRANCIS, Prof. .	Oct. 16, 1874,	Dickinson Coll., Carlisle, Pa.
2438.	HIRST, BARTON COOKE, M.D. . .	Dec. 15, 1899,	1821 Spruce St., Philadelphia.
1663.	HITCHCOCK, CHAS. HENRY, Prof.	April 15, 1870,	Dartmouth Coll., Hanover, N.H.
2355.	HOLDEN, EDWARD S., Prof. . . .	Dec. 17, 1897,	U. S. Military Academy, West Point, N. Y.
2068.	HOLLAND, JAMES W., M.D. . . .	Feb'y 19, 1886,	2006 Chestnut St., Philadelphia.
2440.	HOLMES, WILLIAM H., Prof. . . .	Dec. 15, 1899,	Bureau of Ethnology, U. S. National Museum, Washington, D. C.
1624.	HOOKER, SIR JOSEPH D., LL.D . .	Jan'y 15, 1869,	The Camp, Sunningdale, Eng.
2224.	HOPPIN, J. M., Prof.	Oct. 20, 1893,	New Haven, Conn.
2070.	HORNER, INMAN.	Feb'y 19, 1886,	1811 Walnut St., Philadelphia.
1696.	HOUGH, GEORGE W., Prof.	Jan'y 19, 1872,	N.W. University, Evanston, Ill.
1698.	HOUSTON, EDWIN J., Prof. . . .	Jan'y 19, 1872,	1809 Spring Garden St., Phila.
2346.	HOWE, HENRY M., Prof.	Oct. 15, 1897,	27 W. 73d St., New York.

	Name.	*Date of Election.*	*Present Address.*
2498.	HOWELL, WILLIAM HENRY, Ph.D., Prof.	April 3, 1903,	232 West Lanvale St., Baltimore.
2239.	HUGGINS, SIR WILLIAM, K.C.B.	Feb'y 15, 1895,	90 Upper Tulse Hill, S.W., London, England.
1843.	HUMPHREY, H. C.	July 20, 1877,	?
2248.	HUNTER, RICHARD S.	Feb'y 15, 1895,	1413 Locust St., Philadelphia.
2373.	HUTCHINSON, EMLEN	May 20, 1898,	Aldine Hotel, Philadelphia.

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1773.	INGHAM, WM. ARMSTRONG.	April 16, 1875,	320 Walnut St., Philadelphia.
2217.	D'INVILLIERS, EDWARD VINCENT.	May 19, 1893,	506 Walnut St., Philadelphia.

J

2010.	JAMES, EDMUND J., Pres't.	April 18, 1884,	5833 Monroe Ave, Chicago, Ill.
2302.	JASTROW, MORRIS, JR., Prof.	Feb. 19, 1897,	248 S. 23d St, Philadelphia.
2375.	JAYNE, HENRY LABARRE, LL D.	May 20, 1898,	1826 Chestnut St., Phila.
2049.	JAYNE, HORACE, M.D.	Oct. 16, 1885,	318 S. 19th St., Philadelphia.
1954.	JEFFERIS, WILLIAM W	Jan'y 20, 1882,	442 Central Park West, New York City.
2017.	JORDAN, FRANCIS, JR.	April 18, 1884,	111 N. Front St., Philadelphia.

K

1989.	KANE, ELISHA KENT.	April 20, 1883,	Kushequa, Pa.
2322.	KARPINSKY, ALEX. PETROVITCH, Prof.	May 21, 1897,	Geological Survey, St. Petersburg, Russia.
2169.	KEANE, JOHN J., Right Rev.	Dec. 20, 1889,	Dubuque, Iowa.
2422.	KEASBEY, LINDLEY M., Prof.	Dec. 15, 1899,	Bryn Mawr, Pa.
2329.	KEEN, GREGORY B.	Oct. 15, 1897,	2320 Spruce St., Philadelphia.
2021.	KEEN, WILLIAM W., M.D., LL.D.	July 18, 1884,	1729 Chestnut St., Philadelphia.
2392.	KEISER, EDWARD H., Prof.	Dec. 16, 1898,	Washington University, St. Louis, Mo.
2450.	KELLER, HARRY F., Prof.	May 18, 1900,	Central High School, Phila.
1723.	KELVIN, RIGHT HON. LORD	April 18, 1873,	The Library, The University, Glasgow, Scotland.
2278.	KENNELLY, A. E., D.Sc	Feb. 28, 1896,	Harvard University, Cambridge, Mass.
2392.	KNIGHT, WILLIAM A., Prof.	Dec. 16, 1898,	St. Andrew's, Scotland.
1767.	KÖNIG, GEORGE A., Prof.	Oct. 16, 1874,	School of Mines, Houghton, Mich.
2424.	KRAEMER, HENRY, Prof.	Dec. 15, 1899,	145 N. 10th St., Philadelphia.
2167.	KRAUSS, FRIEDRICH S., Ph.D.	Dec. 20, 1889,	VII² Neustiftgasse 12, Vienna, Austria.

L

1694.	LAMBERT, GUILLAUME, Prof.	Jan'y 19, 1872,	42 Boulevard Bischoffsheim, Brussels, Belgium.
2411.	LAMBERTON, WILLIAM A., Prof	May 19, 1899,	University of Penna., Phila.
2377.	DE LANCEY, EDWARD F	May 20, 1898,	20 E. 28th St., New York.
2344.	LANCIANI, RUDOLFO, Prof.	Oct. 15, 1897,	2 Via Goito, Rome, Italy.
1858.	LANDRETH, BURNET.	Jan'y 18, 1878,	Bristol, Pa.
1781.	LANGLEY, SAMUEL P., LL.D.	April 16, 1875,	Smithsonian Institution, Washington, D. C.
2505.	LANKESTER, EDWIN RAY, LL.D., F.R.S.	April 3, 1903,	British Museum, Cromwell Rd., London, S. W., Eng.

	Name.	*Date of Election.*	*Present Address.*
1721.	La Roche, C. Percy, M.D. . . .	Jan'y 17, 1873,	1518 Pine Street, Philadelphia.
1595.	Lea, Henry Charles, LL.D. . .	Oct. 18, 1867,	2000 Walnut St., Philadelphia.
2407.	Learned, Marion D., Prof . . .	May 19, 1899,	University of Penna., Phila.
1986.	Lehman, Ambrose E.	April 20, 1883,	506 Walnut St., Philadelphia.
2174.	Le Moine, Sir James M.	Dec. 20, 1889,	Spencer Grange, Quebec, Canada.
1934.	Leroy-Beaulieu, Paul, Prof. .	April 15, 1881,	27 Ave. du Bois de Boulogne, Paris, France.
2085.	Levasseur, Emile, Prof.	May 21, 1886,	26 Rue Mons. le Prince, Paris, France.
2300.	Lewis, G. Albert	Dec. 18, 1896,	1834 DeLancey Place, Phila.
2338.	Libbey, William, Prof.	Oct. 15, 1897,	20 Bayard Ave., Princeton, N.J.
2432.	Lippincott, J. Dundas	Dec. 15, 1899,	1333 Walnut St., Philadelphia.
2312.	Lister, The Right Hon. Lord .	May 21, 1897,	12 Park Crescent, Portland Place, London, England.
1756.	Lockyer, Sir Joseph Norman, K.C.B	April 17, 1874,	Royal College of Science, S. Kensington, London, S. W., England.
2460.	Lodge, Sir Oliver Joseph, LL.D.	Feb'y 15, 1901,	The University, Birmingham, England.
2435.	Loeb, Jacques, Dr.	Dec. 15, 1899,	University of California, Berkeley, Cal.
1872.	Longstreth, Morris, M.D. . . .	Sept. 20, 1878,	1416 Spruce St., Philadelphia.
2202.	Low, Hon. Seth	Feb. 19, 1892,	30 E. 46th St., New York.
2350.	Lowell, Percival	Oct. 15, 1897,	53 State St., Boston.
1629.	Lyman, Benjamin Smith	Jan'y 15, 1869,	708 Locust St., Philadelphia.

M

2319.	Mabery, Charles F., Prof. . . .	May 21, 1897,	57 Adelbert St., Cleveland, O.
2107.	MacAlister, James, Pres't. . . .	Dec. 17, 1886,	119 N. 18th St., Philadelphia.
2207.	Macfarlane, John M., Prof. . .	Dec. 16, 1892,	Lansdowne, Delaware Co., Pa.
2404.	Mackenzie, Arthur S., Prof. . .	May 19, 1899,	Bryn Mawr, Pa.
2363.	McCay, Leroy W., Prof.	Dec. 17, 1897,	Princeton, N. J.
2366.	McClure, Charles F. W., Prof .	Dec. 17, 1897,	Princeton, N. J.
2280.	McCook, Henry C., Rev., D.D. .	Feb. 28, 1896,	3700 Chestnut St., Philadelphia.
1888.	McCreath, Andrew S.	July 18, 1879,	223 Market St., Harrisburg, Pa.
2299.	Magie, Wm. Francis, Prof. . . .	Dec. 18, 1896,	Princeton, N. J.
2339.	Mahan, Alfred T., Capt. U.S.N.	Oct. 15, 1897,	160 W. 86th St., New York.
2042.	Mallet, John Wm., M.D. . . .	Jan'y 16, 1885,	University of Virginia, Charlottesville, Va.
1847.	Mansfield, Ira Franklin . . .	Jan'y 18, 1878,	Beaver, Beaver Co., Pa.
1857.	March, Francis Andrew, Prof.	Jan'y 18, 1878,	Lafayette College, Easton, Pa.
2461.	Marconi, Guglielmo	Feb'y 15, 1901,	The Haven Hotel, Sand Barths, Poole, Dorset, England.
2463.	Marcovnikoff, Vladimir, Prof..	Feb'y 15, 1901.	Imp. Moskovsky Universitet, Moscow, Russia.
1861.	Marks, William D., Prof. . . .	May 3, 1878,	Westport, Essex Co., N. Y.
2078.	Marshall, John, M.D	May 21, 1886,	1718 Pine St., Philadelphia.
2184.	Mascart, E., Prof.	Dec. 19, 1890,	176 Rue de l'Université, Paris, France.
1572.	Mason, Andrew	Jan'y 18, 1867,	30 and 32 Wall St., New York.
2431.	Mason, Otis T., Prof.	Dec. 15, 1899,	U. S. National Museum, Washington, D. C.
2279.	Mason, Wm. Pitts, M.D., Prof. .	Feb. 28, 1896,	Rensselaer Polytechnic Institute, Troy, N. Y.
2196.	Maspero, Gaston Camille, Prof.	May 15, 1891,	Paris, France.

	Name.	*Date of Election.*	*Present Address.*
2427.	MATTHEWS, ALBERT.	Dec. 15, 1899,	145 Beacon St., Boston.
2399.	MEIGS, ARTHUR V., M.D.	May 19, 1899,	1322 Walnut St., Philadelphia.
2456.	MEIGS, WILLIAM M	Feb'y 15, 1901,	1815 Pine St., Philadelphia.
2115.	VON MELTZEL, HUGO, Prof. Dr. .	Dec. 17, 1886,	Koloszvar, Hungary.
2330.	MELVILLE, GEO. W., Rear Admiral.	Oct. 15, 1897,	Navy Dept., Washington, D. C.
2430.	MENDENHALL, THOMAS C , Prof.	Dec. 15, 1899,	Worcester, Mass.
2387.	MENGARINI, GUGLIELMO, Prof. .	May 20, 1898,	Rome, Italy.
2251.	MERCER, HENRY C.	Feb. 15, 1895,	Doylestown, Pa.
2485.	MERRIAM, C. HART, Dr.	April 4, 1902,	U. S. Biological Survey, Dep't of Agriculture, Washington, D. C.
1903.	MERRICK, JOHN VAUGHAN. . . .	April 16, 1880,	Roxborough, Philadelphia.
1947.	MERRIMAN, MANSFIELD, Prof. .	Oct. 21, 1881,	Lehigh Univ., Bethlehem, Pa.
1744.	MESSCHERT, MATTHEW HUIZINGA.	Oct. 17, 1873,	Douglassville, Berks Co., Pa.
2436.	MEYER, ADOLPH B., Prof. . . .	Dec. 15, 1899,	K. Zoölogisches u. Anthropologisch-Ethnographisches Museum, Dresden, Germany.
2142.	MICHAEL, MRS. HELEN ABBOTT .	May 20, 1887,	140 Beacon St., Boston.
2484.	MICHELSON, ALBERT A., Prof., Sc.D. (Cantab)	April 4, 1902,	University of Chicago, Chicago, Ill.
2423.	MILLER, LESLIE W., Prof. . . .	Dec. 15, 1899,	N. W. cor. Broad and Pine Sts., Philadelphia.
2284.	MINOT, CHAS. SEDGWICK, M.D. .	May 15, 1896,	Harvard Univ., Cambridge, Mass.
2175.	MITCHELL, HON. JAMES T. . . .	Feb'y 21, 1890,	1722 Walnut St., Philadelphia.
1461.	MITCHELL, S. WEIR, M.D	Jan'y 17, 1862,	1524 Walnut St., Philadelphia.
2267.	MONTEGAZA, PAOLO	May 17, 1895,	Florence, Italy.
2367.	MONTGOMERY, THOS. H., Jr., Prof.	Feb'y 18, 1898,	Univ. of Texas, Austin, Texas.
2323.	MOORE, CLARENCE B.	Oct. 15, 1897,	1321 Locust Street, Phila.
2029.	MOORE, JAMES W., M.D.	Jan'y 16, 1885,	Lafayette College, Easton, Pa.
1841.	MOREHOUSE, GEORGE R., M.D. .	April 20, 1877,	2033 Walnut St., Philadelphia.
2499.	MORLEY, EDWARD W., Ph.D., LL.D.	April 3, 1903,	Adelbert College, Cleveland, Ohio.
2340.	MORLEY, FRANK, Prof.	Oct. 15, 1897,	Johns Hopkins University, Baltimore.
2409.	MORRIS, HARRISON S.	May 19, 1899,	Academy of Fine Arts, Philadelphia.
2397.	MORRIS, ISRAEL W.	May 19, 1899,	225 So. 8th St., Philadelphia.
1976.	MORRIS, J. CHESTON, M.D. . . .	Jan'y 19, 1883,	1514 Spruce St., Philadelphia.
2454.	MORRIS, JOHN T.	Feb'y 15, 1901,	826 Drexel Building, Phila.
2265.	MORSE, EDWARD S., Prof. . . .	May 17, 1895,	Essex Institute, Salem, Mass.
2300.	MORSE, HARMON N., Ph.D. . . .	April 3, 1903,	1117 N. Eutaw St., Baltimore.
2121.	MUCH, MATHÆUS, Ph.D., Prof. .	Dec. 17, 1886,	XIII Penzingerstrasse, 84, Vienna, Austria.
2464.	MUNRO, DANA C., Prof.	May 17, 1901,	Univ. of Wisconsin, Madison, Wis.
2192.	MUNROE, CHARLES E., Prof. . .	May 15, 1891,	Columbian Univ., Washington, D. C.
2062.	MURDOCK, J. B., Com. U.S.N. . .	Feb'y 19, 1886,	Navy Dept., Washington, D.C.
1937.	MURRAY, JAMES A. H., LL.D . .	April 15, 1881,	Sunnyside, Banbury Road, Oxford, England.

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2087.	DE NADAILLAC, MARQUIS.	May 21, 1886,	18 Rue Duphot, Paris, France.
2316.	NANSEN, FRIDTJOF, Prof.	May 21, 1897,	Godthaab, Lysaker, Norway.
1852.	NEWCOMB, SIMON, Prof.	Jan'y 18, 1878,	1620 P St., Washington, D. C.

	Name.	*Date of Election.*	*Present Address.*
1703.	NICHOLS, STARR HOYT, Rev . . .	July 19, 1872,	128 Main St., Danbury, Conn.
2060.	NIKITIN, SERGI, Prof.	Feb'y 19, 1886,	Geological Survey, St. Petersburg, Russia.
1712.	NORRIS, ISAAC, M.D.	Oct. 18, 1872,	Fair Hill, Bryn Mawr, Pa.
2269.	NUTTALL, MRS. ZELIA	May 17, 1895,	Plaza de Alvarado, Coyoacán. D. F. Mexico.

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2072.	OLIVER, CHARLES A., M.D. . . .	Feb'y 19, 1886,	1507 Locust St., Philadelphia.
2354.	OLNEY, RICHARD, Hon	Dec. 17, 1897,	23 Court Street, Boston.
2195.	OPPERT, JULES, Prof	May 15, 1891,	2 Rue de Sfax, Paris, France.
2362.	ORTMANN, ARNOLD E., Prof. . . .	Dec. 17, 1897,	Carnegie Museum, Shenley Park, Pittsburg, Pa.
2135.	OSBORN, HENRY F., Prof.	Feb'y 18, 1887,	American Museum of Natural History, New York.
2039.	OSLER, WILLIAM, M.D	Jan'y 16, 1885,	1 West Franklin St., Baltimore, Md.

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1868.	PACKARD, ALPHEUS S., Prof. . .	Sept. 20, 1878,	Providence, R. I.
1578.	PACKARD, JOHN H., M.D.	Jan'y 18, 1867,	University Club, Philadelphia.
2395.	PANCOAST, HENRY S	Dec. 16, 1898,	267 E. Johnson St., Germantown, Phila.
2035.	PATTERSON, C. STUART.	Jan'y 16, 1885,	1000 Walnut St., Philadelphia.
2452.	PATTERSON, EDWARD, Hon. . . .	May 18, 1900,	Supreme Court, Appellate Div., 1st Dept., New York City.
2385.	PATTERSON, LAMAR GRAY . . .	May 20, 1898,	Guano, Amherst Co., Va.
1282.	PATTERSON, ROBERT	April 18, 1851,	329 Chestnut St., Philadelphia.
1320.	PATTERSON, THOMAS LEIPER . .	April 15, 1853,	176 Washington St., Cumberland, Md.
2213.	PATTISON, ROBERT E., Hon . . .	Feb. 17, 1893,	5930 Drexel Rd., Overbrook, Pa.
2357.	PATTON, FRANCIS L., D.D., Pres't	Dec. 17, 1897,	Princeton, N. J.
2428.	PAUL, J. RODMAN	Dec. 15, 1899,	903 Pine St., Philadelphia.
1772.	PEARSE, JOHN B.	Jan'y 15, 1875,	317 Walnut Av., Roxbury, Mass.
2318.	PECKHAM, S. F., Prof	May 21, 1897,	49 Pacific St., Brooklyn.
1859.	PEIRCE, C. NEWLIN, D.D.S. . . .	May 3, 1878,	3316 Powelton Ave., Philadelphia.
1722.	PEMBERTON, HENRY.	Jan'y 17, 1873,	1947 Locust St., Philadelphia.
2104.	PEÑAFIEL, ANTONIO, Dr	May 21, 1886,	Ciudad Mexico, Mexico.
2455.	PENNIMAN, JOSIAH H., Prof. . .	Feb'y 15, 1901,	4326 Sansom St., Philadelphia.
2073.	PENNYPACKER, SAMUEL W., Hon.	May 21, 1886,	Executive Mansion, Harrisburg, Pa.
1518.	PENROSE, R. A. F., M.D. . . .	July 17, 1863,	1331 Spruce St., Philadelphia.
2059.	PEPPER, EDWARD, M.D.	Feb'y 19, 1886,	El Afia, El Biar, Alger, Algerie.
2333.	PEPPER, GEORGE WHARTON, LL.D.	Oct. 15, 1897,	701 Drexel Building, Phila.
2383.	PETTEE, WILLIAM HENRY, Prof.	May 20, 1898,	554 Thompson St., Ann Arbor, Mich.
2281.	PETTIT, HENRY	Feb. 28, 1895,	5951 Overbrook Ave., Philadelphia.
2403.	PHILLIPS, FRANCIS C., Prof. . .	May 19, 1899,	P. O. Box 126, Allegheny, Pa.
2296.	PICKERING, EDW. C., Prof. . . .	May 15, 1896,	Harvard Univ., Cambridge, Mass.
2342.	PIERSOL, GEORGE A., M.D. . . .	Oct. 15, 1897,	Chester Ave. and 49th St., Philadelphia.
2277.	PILSBRY, HENRY A., Prof. . . .	Dec. 20, 1895,	Academy of Natural Sciences, Philadelphia.
2374.	PLATT, CHARLES.	May 20, 1898,	237 S. 18th St., Philadelphia.

Name.	*Date of Election.*	*Present Address.*
2415. POINCARÉ, HENRI, Prof.	May 19, 1899,	63 Rue Claude Bernard, Paris, France.
2053. POMIALOWSKY, JOHN, Prof. . . .	Oct. 16, 1885,	St. Petersburg, Russia.
2097. POSTGATE, JOHN P., Prof.	May 21, 1886,	Cambridge, England.
2437. PREECE, SIR WM. HENRY, F.R.S.	Dec. 15, 1899,	12, Queen Anne's Gate, London, S. W., England.
2382. PRESCOTT, ALBERT B., LL.D., Prof.	May 20, 1898,	734 S. Ingalls St., Ann Arbor, Mich.
1780. PRIME, FREDERICK	April 16, 1875,	1008 Spruce St., Philadelphia.
2414. PRITCHETT, HENRY S, LL.D., President	May 19, 1899,	Massachusetts Institute of Technology, Boston.
1758. PUMPELLY, RAPHAEL, Prof. . . .	April 17, 1874,	Newport, R. I.
2293. PUPIN, MICHAEL I., Prof. . .	May 15, 1896,	7 Highland Pl., Yonkers, N. Y.
2268. PUTNAM, FREDERICK W., Prof. .	May 15, 1895,	Peabody Museum, Cambridge, Mass.

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2131. RADA, JUAN DE DIOS-Y DELGADO,	Dec. 17, 1886,	Calle de la Corredera baja de S. Pablo No. 12, Madrid, Spain.
2401. RAMSAY, SIR WILLIAM	May 19, 1899,	University College, Gower St. W. C., London, Eng.
1849. RANDALL, F. A., M.D.	Jan'y 18, 1878,	Warren, Pa.
2465. RAVENEL, MAZŸCK P., Dr.	May 17, 1901,	University of Pennsylvania, Philadelphia.
2388. RAWLE, FRANCIS.	Dec. 16, 1898,	328 Chestnut St., Philadelphia
2398. RAWLE, WILLIAM BROOKE. . . .	May 19, 1899,	230 So. 22d St., Philadelphia.
2099. RAYLEIGH, The Right Hon. Lord.	May 21, 1886,	Terling Pl., Witham, Essex, Eng.
1784. RAYMOND, ROSSITER W.	April 16, 1875,	99 John St., New York, N. Y.
2381. REDWOOD, BOVERTON	May 20, 1898,	4, Bishopsgate St. Within, E. C., London, England.
2405. RÉMINGTON, JOSEPH P., Prof. . .	May 19, 1899,	1832 Pine St., Philadelphia.
1889. REMSEN, IRA, President.	July 18, 1879,	Johns Hopkins Univ., Baltimore, Md.
1890. RENEVIER, E., Prof.	July 18, 1879,	Univ., Lausanne, Switzerland.
2443. RENNERT, HUGO A., Prof.	Dec. 15, 1899,	4232 Chestnut St., Philadelphia.
1816. REULEAUX, F., Prof.	Feb'y 2, 1877,	W. Ahornstrasse 2, Berlin, Germany.
2122. RÉVILLE, ALBERT, Prof.	Dec. 17, 1886,	21 Rue Guénégaud, Paris, France.
2472. RICHARDS, THEO. WILLIAM, Prof.	April 4, 1902,	15 Follen St., Cambridge, Mass.
2226. ROBERTS, ISAAC, Sc.D., F.R.S. . .	Oct. 20, 1893,	Starfield, Crowborough, Sussex, England.
1957. ROBINS, JAMES W., Rev	April 21, 1882,	2115 Pine St., Philadelphia.
2177. ROGERS, ROBERT W., Prof. . . .	Feb'y 21, 1890,	Drew Theological Seminary, Madison, N. J.
1462. RÖHRIG, F. L. OTTO, Prof.	April 18, 1862,	4025 Oakland Ave., Pasadena, Cal.
2050. ROLLETT, HERMANN, Ph.D. . . .	Oct. 16, 1885,	Baden bei Wien, Austria
2506. ROSCOE, SIR HENRY E, F.R.S., D.C.L.	April 3, 1903,	Woodcote Lodge, West Horsley, Leatherhead, England.
2198. ROSENGARTEN, JOSEPH G.	Oct. 16, 1891,	1701 Walnut St., Philadelphia.
1964. DE ROSNY, LÉON, Prof.	July 21, 1882,	28 Rue Mazarine, Paris, France
1838. ROTHROCK, JOSEPH T., Prof. . .	April 20, 1877,	West Chester, Pa.

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	Name.	*Date of Election*	*Present Address.*
2230.	SACHSE, JULIUS F., Litt.D.	Feb'y 16, 1894,	4128 Pine St., Phila.
1766.	SADTLER, SAMUEL P., Prof.	Oct. 16, 1874,	N.E. cor. 10th and Chestnut Sts., Philadelphia.
2148.	SAJOUS, CHARLES E., M.D.	Feb'y 17, 1888,	2043 Walnut St., Philadelphia.
2358.	SAMPSON, ALDEN.	Dec. 17, 1897,	Haverford, Pa.
1563.	SANDBERGER, FREDOLIN, Prof.	April 20, 1866,	Univ. of Würzburg, Würzburg, Bavaria.
2327.	SANDERS, RICHARD H.	Oct. 15, 1897,	1225 Locust St., Philadelphia.
1958.	SARGENT, CHARLES SPRAGUE, Prof	April 21, 1882,	Jamaica Plain, Mass.
1730.	DE SAUSSURE, HENRI.	April 18, 1873,	Geneva, Switzerland.
2473.	SCHELLING, FELIX E., Ph.D., Prof.	April 4, 1902,	4211 Sansom St., Philadelphia.
2468.	SCHIAPARELLI, GIOVANNI	Feb'y 15, 1901,	Royal Observatory, Milan, Italy.
1864.	SCHURZ, CARL, Hon	Sept. 20, 1878,	54 William St., New York.
1725.	SCLATER, PHILIP LUTLEY, Ph.D.	April 18, 1873,	3 Hanover Square, London, W., England.
2372.	SCOTT, CHARLES F.	Feb'y 18, 1898,	Westinghouse Electric Co., Pittsburgh, Pa.
2112.	SCOTT, WILLIAM B., Prof.	Dec. 17, 1886,	Princeton, N. J.
1870.	SCUDDER, SAMUEL HUBBARD.	Sept. 20, 1878,	Cambridge, Mass.
2352.	SEE, THOMAS J. J., LL.D.	Dec. 17, 1897,	Mare Island Observatory, Cal.
1704.	SELLERS, COLEMAN, Sc.D.	July 19, 1872,	3301 Baring St., Philadelphia.
2420.	SELLERS, COLEMAN, JR.	Dec. 15, 1899,	410 N. 33d St., Philadelphia.
1533.	SELLERS, WILLIAM.	April 15, 1864,	1819 Vine St., Philadelphia.
2057	SERGI, GIUSEPPE, Prof.	Oct. 16, 1885,	Università Romana, Rome, Italy
2076.	SHARP, BENJAMIN, M.D.	May 21, 1886,	Academy of Natural Sciences, Philadelphia.
1960.	SHARPLES, STEPHEN PASCHALL, Prof.	April 21, 1882,	26 Broad St., Boston, Mass.
1797.	SHERWOOD, ANDREW	Oct. 15, 1875,	Mansfield, Tioga Co., Penna.
1822.	SHIELDS, CHAS. W., LL.D., Rev.	Feb'y 2, 1877,	Princeton, N. J.
2442.	SIGSBEE, CHARLES D., Admiral, U.S.N.	Dec. 15, 1899,	League Island Navy Yard, Philadelphia.
2449.	SINKLER, WHARTON, M.D.	May 18, 1900,	1606 Walnut St., Philadelphia
2351.	SMITH, A. DONALDSON, M.D.	Oct. 15, 1897,	1820 Chestnut St., Phila.
2146.	SMITH, EDGAR F., Prof.	Oct. 21, 1887,	3421 Walnut St., Philadelphia.
1789.	SMITH, STEPHEN, M.D	Oct. 15, 1875,	57 W. 42d St., New York.
2335.	SMOCK, JOHN C., Prof.	Oct. 15, 1897,	Trenton, N. J.
2141.	SMYTH, ALBERT H., Prof.	May 20, 1887,	5214 Main St., Germantown, Philadelphia.
2229.	SNELLEN, HERMAN, JR., Ph.D.	Feb'y 16, 1894,	Utrecht, Netherlands.
1742.	SNOWDEN, A. LOUDON	Oct. 17, 1873,	1812 Spruce St., Philadelphia.
2009.	SNYDER, MONROE B., Prof.	Jan'y 18, 1884,	2402 N. Broad St., Philadelphia.
1720.	SPOFFORD, A. R., LL.D	Jan'y 17, 1873,	Library of Congress, Washington, D. C.
2502.	STENGEL, ALFRED, M.D.	April 3, 1903,	1811 Spruce St., Philadelphia.
2348.	STEPHENS, H. MORSE, Prof.	Oct. 15, 1897,	University of California, Berkeley, Cal.
1990.	STEVENS, WALTER LECONTE, Prof.	Jan'y 18, 1884,	Lexington, Va.
1840.	STEVENSON, JOHN JAMES, Prof.	April 20, 1877,	University Heights, New York
2276.	STEVENSON, SARA Y., Sc.D.	Oct. 18, 1895,	237 S. 21st St., Philadelphia.
2371.	STILLWELL, L. B.	Feb'y 18, 1898,	6th St., Lakewood, N. J.
2486.	STONEY, G. JOHNSTONE, Prof., F.R.S.	April 4, 1902,	30 Ledbury Rd., Bayswater, London, W., Eng.

	Name.	Date of Election.	Present Address.
2094.	SUESS, EDUARD, Prof.	May 21, 1886,	K. K. Geologische Reichsan stalt, Vienna, Austria.
2258.	SULZBERGER, MAYER, Hon. . . .	May 17, 1895,	1303 Girard Ave., Philadelphia.
2092.	SZOMBATHY, JOSEF, Prof.	May 21, 1886,	Burgring 7, Vienna, Austria.
	T		
2328.	TATHAM, WILLIAM	Oct. 15, 1897,	1811 Walnut St., Philadelphia
2098.	TEMPLE, RICHARD CARNAC, Col. .	May 21, 1886,	Port Blair, Andaman Islands, Bengal, India.
2289.	TESLA, NIKOLA, LL.D.	May 15, 1896,	Wardenclyffe, Long Island, N.Y.
2006.	THOMAS, ALLEN C., Prof.	Jan'y 18, 1884,	Haverford, Pa.
1993.	THOMPSON, HEBER S.	Jan'y 18, 1884,	Sheafer Build'g, Pottsville, Pa.
1726.	THOMPSON, SIR HENRY, Bart . .	April 18, 1873,	35 Wimpole St., Cavendish Square, London, England.
2488.	THOMPSON, SILVANUS P., Prof., F.R.S.	April 4, 1902,	Technical College, Finsbury, Leonard St, City Rd., E. C., Eng.
1807.	THOMSON, ELIHU, Prof.	April 21, 1876,	Swampscott, Mass.
2507.	THOMSON, JOSEPH JOHN, D.Sc., F.R.S	April 3, 1903,	TrinityCollege, Cambridge, Eng.
1909.	THOMSON, WILLIAM, M.D.	April 16, 1880,	1426 Walnut St., Philadelphia
2052.	IM THURN, EVERARD F.	Oct. 16, 1885,	Queens College, Neawara Eliya, Ceylon.
1530.	THURY, A., Prof.	April 15, 1864,	Univ. of Geneva, Geneva, Switzerland.
2471.	TILGHMAN, BENJAMIN CHEW . .	April 4, 1902,	1126 S. 11th St., Philadelphia.
2123.	TOPINARD, PAUL, Prof.	Dec. 17, 1886,	105 Rue de Rennes, Paris, France.
2249.	TOWER, CHARLEMAGNE, JR., LL.D., Hon.	Feb'y 15, 1895,	U. S. Embassy, Berlin, Gemany.
2503.	TRELEASE, WILLIAM, Sc.D	April 3, 1903,	Missouri Botanical Garden, St. Louis, Mo.
2413.	TREVELYAN, GEORGE OTTO, Rt. Hon. Sir	May 19, 1899,	8 Grosvenor Crescent, S. W. London, England.
2288.	TROWBRIDGE, JOHN, Prof.	May 15, 1896,	Harv. Univ., Cambridge, Mass.
2441.	TRUE, FREDERICK WILLIAM, Dr .	Dec. 15, 1899,	U. S. National Museum, Washington, D. C.
1973.	TSCHERMAK, GUSTAV.	Oct. 20, 1882,	Universität, Vienna. Austria.
2321.	TSCHERNYSCHEW, THEODORE, Prof.	May 21, 1897,	Geological Survey, St. Petersburg, Russia.
1529.	v. TUNNER, PETER R., Prof. . . .	April 15, 1864,	Leoben, Austria.
1983.	TURRETTINI, THEODORE, Prof . .	Dec. 19, 1890,	Geneva, Switzerland.
2166.	TUTTLE, DAVID Kk., Ph.D.	Oct. 18, 1889,	U. S. Mint, Philadelphia.
2163.	TYLER, LYON G., Hon., Pres't . .	Oct. 18, 1889,	Williamsburg, Va.
2138.	TYSON, JAMES, M.D	May 20, 1887,	1506 Spruce St., Philadelphia.
	U		
2185.	UNWIN, WILLIAM C., Prof.	Dec. 19, 1890,	7 Palace Gate Mansions, London, England.
	V		
2400.	VAUCLAIN, SAMUEL M.	May 19, 1899,	1533 Green St., Philadelphia.
2325.	VAUX, GEORGE, JR.	Oct. 15, 1897,	404 Girard Building, Phila.
1670.	VOSE, GEORGE L., Prof.	Oct. 21, 1870,	Brunswick. Maine.

Name.	*Date of Election.*	*Present Address.*
2186. VOSSION, LOUIS	Dec. 19, 1890,	Consulate of France, Bombay, India.
2508. DE VRIES, HUGO, Prof.	April 3, 1903,	University of Amesterdam, Amsterdam, Netherlands.
W		
2034. WAGNER, SAMUEL	Jan'y 16, 1885,	Greenbank Farm, West Chester, Pa.
1748. WAHL, WILLIAM H., Ph.D. . . .	Jan'y 16, 1874,	15 S. 7th St., Philadelphia.
2331. WALCOTT, CHARLES D., LL.D. .	Oct. 15, 1897,	U. S. Geological Survey, Washington, D. C.
1724. WALLACE, ALFRED RUSSEL, LL.D.	April 18, 1873,	Parkstone, Dorset, England.
2156. WARD, LESTER F., LL.D.	May 17, 1889,	1464 Rhode Island Ave., Washington, D. C.
1925. WARE, LEWIS S	Jan'y 21, 1881,	Phila.BookCo.,15 S.9th St.,Phila.
2359. WARFIELD, ETHELBERT D., Pres't	Dec. 17, 1897,	Easton, Pennsylvania.
2033. WEIL, EDWARD HENRY	Jan'y 16, 1885,	1720 Pine St., Philadelphia.
2286. WELCH, WILLIAM H., M.D. . . .	May 15, 1896,	935 St. Paul St., Baltimore, Md.
1639. WHARTON, JOSEPH.	April 16, 1869,	P. O. Box 1332, Philadelphia.
1637. WHITE, ANDREW D., Hon.	April 16, 1869,	White Library, Cornell Univ., Ithaca, N. Y.
1848. WHITE, ISRAEL C., Prof.	Jan'y 18, 1878,	119 Wiley St., Morgantown, W. Va.
2384. WHITFIELD, R. P., Prof. . . .	May 20, 1898,	American Museum of Natural History, New York.
2439. WHITMAN, CHARLES OTIS, Prof. .	Dec. 15, 1899,	University of Chicago, Chicago, Ill.
1863. WILDER, BURT G., Prof.	May 3, 1878,	60 Cascadilla Pl., Ithaca, N. Y.
2250. WILLCOX, JOSEPH	Feb. 15, 1895,	"The Clinton," 10th and Clinton Sts., Philadelphia.
2347. WILLIAMS, EDWARD H., JR., Prof.	Oct. 15, 1897,	53 Phillips St., Andover, Mass.
2151. WILLIAMS, TALCOTT, LL.D. . . .	May 18, 1888,	916 Pine Street, Philadelphia.
2178. WILLIS, HENRY, Prof.	Feb'y 21, 1890,	4036 Baring St., Philadelphia.
2041. WILSON, JAMES CORNELIUS, M.D.	Jan'y 16, 1885,	1511 Walnut St., Philadelphia.
2137. WILSON, WILLIAM POWELL, M.D. .	May 20, 1887,	233 S. 4th St., Philadelphia.
2341. WILSON, WOODROW, Pres't. . . .	Oct. 15, 1897,	Prospect, Princeton, N. J.
2216. WISTAR, GEN. ISAAC J.	May 19, 1893,	S. E. Cor. Spruce and 17th Sts., Philadelphia.
2314. WISTER, OWEN	May 21, 1897,	328 Chestnut Street, Phila.
2343. WITMER, LIGHTNER, Ph.D., Prof.	Oct. 15, 1897,	University of Penna , Phila.
1884. WOOD, RICHARD.	April 18, 1879,	1620 Locust St , Philadelphia.
2408. WOOD, STUART.	May 19, 1899,	1620 Locust St., Philadelphia.
1762. WOODWARD, HENRY, LL.D., F.R.S.	July 17, 1874,	British Museum, London, England.
2478. WOODWARD, ROBERT S., Ph.D., Prof.	April 4, 1902,	408 West 145th St., New York.
2290. WRIGHT, ARTHUR W., Ph.D., Prof.	May 15, 1896,	73 York Sq., New Haven, Conn.
2448. WRIGHT, WILLIAM ALDIS, LL.D .	Feb'y 16, 1900,	Trinity College, Cambridge, England.
2244. WUNDT, WILLIAM, Prof.	Feb. 15, 1895,	Leipzig, Germany.
2426. WURTS, ALEXANDER JAY	Dec. 15, 1899,	Nernst Lamp Co., Pittsburg, Pa.
1932. WURTS, CHARLES STEWART, M.D.	Jan'y 21, 1881,	1701 Walnut St., Philadelphia.
2061. WYCKOFF, A. B., Lieut. U. S. N. .	Feb'y 19, 1886,	Navy Department, Washington, D. C.
Y		
1904. YARNALL, ELLIS	April 16, 1880,	420 Walnut St., Philadelphia.
1759. YOUNG, CHARLES AUGUSTUS, Prof.	April 17, 1874,	16 Prospect Av., Princeton, N. J.